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Air-Break Switches*

By W. P. Hammond

THE question as to the feasibility of the use of air break switches for opening heavily loaded circuits has apparently never been definitely settled, much having been said regarding the danger to equipment attending their use as well as the advantages to be derived therefrom. With the idea of obtaining data from which some definite conclusion might be drawn on this question, there was conducted at Gainesville, Ga., during the months of February and March of this year, a series of experiments extending over three or four weeks, the work being carried out under the direction of Mr. C. E. Bennett, electrical engineer.

The site chosen for the tests is situated about four miles northwest of the city of Gainesville proper, adjacent to the Old Dunlap Power Plant of the Georgia Railway & Power Company and the new high tension lines of this company between Tallulah Falls and Atlanta. The entire output of this station was available for power purposes during the tests, and the high tension lines could be used after twelve o'clock at night to furnish the necessary load. With such ideal location and facilities no expense was spared in making the tests as exhaustive as possible, and the original report contains data on some 275 tests with more than fifty 8-inch by 10-inch photographs and a number of oscillograph records; the instrument for obtaining these records being loaned by the General Electric Company. The several weeks during which the tests were conducted made it possible to note the behavior of the different switches in all kinds of weather. Some of the tests were conducted during a snow storm, some during rain and wind storms, and others in fair weather with practically no wind.

Fig. 1 shows a general view of the switch structure and the manner of connecting up the switches, the incoming leads from the power house being in the extreme right of the picture and the wires connecting with the high tension tower lines immediately above. The

(Continued on page 292.)

* From the *General Electric Review*.

Electric arcs produced by operating a 116,000-volt transmission line by an air-break switch.

How to Collect and Preserve Insects—I*

Methods and Apparatus Used in an Interesting Pastime

By Frank E. Lutz

"INSECTS are hexapodous tracheate arthropods," which doesn't help much unless it be translated. On the part of laymen, however, and *this article is intended for laymen*, there is a good deal of haziness as to what are insects and what are not. Arthropods are creatures having jointed appendages but no internal skeleton. The group includes crabs, spiders and centipedes, as well as insects. The tracheate part refers to the structure of the breathing apparatus, but need not concern us here, for "hexapodous" settles the whole matter if one does not object to exceptions. An arthropod with no more than six legs is fairly certain to be an insect. The exceptions to this are minute immature forms not likely to be noticed by the reader. However, a young insect is an insect just as truly as is a full grown one, and while some young insects (flies, for example) have no legs, others (young butterflies, for example) have more than six legs. Perhaps if we call these exceptions maggots and caterpillars, enough will have been said. No mention has been made of wings for two reasons: very many insects never have wings, and no insect has any wings nor even signs of wings when very young. It may be said here that when an insect does have fully developed wings it is full grown. A small winged fly never grows to be a larger fly as many suppose. Most insects have an outwardly quiet stage, called the pupa, between the crawling larval and the flying adult ones, but many other insects remain active, merely gaining more and more fully developed wings at each moult. Compare in this respect the butterflies and the grasshoppers.

WHEN AND WHERE TO FIND INSECTS.

Insect hunting is a sport in which there are no blanks if you know the game. Frequently the most unpromising times and places are the best, for others have been discouraged by the outlook and you get what they have missed. We can never truly say that we know an insect's haunts until we can tell where to look for it every hour of every day in the year. Many insects are great hiders and should be looked for under bark, in rotten wood, under stones, dead leaves, etc.; among the roots of plants, in their stems and flowers—in short, everywhere and at all times.

* Guide Leaflet No. 39, published by the American Museum of Natural History.

COLLECTING APPARATUS AND HOW TO USE IT.

The great essentials for insect collecting were given each of us at birth and need only be improved by use—an inquiring mind, eyes, and fingers. Only a very few insects sting to such an extent that collecting with unaided fingers is uncomfortable, and even the swiftest fliers can be caught by hand when they are young or asleep. However, certain tools are handy. They can either be made at home or purchased rather cheaply from dealers.

Mention of insect collecting immediately suggests a net. For the capture of adult butterflies, moths, and other delicate flying creatures this should be of the lightest possible material. Fine Brussels net or bobinet is used for the larger sizes (one half foot in diameter) and silk veiling for the pocket sizes. The depth of this net should be at least twice the diameter of its rim (Fig. 1), so that when an insect is caught a twist will fold the bag against the rim and leave the insect imprisoned in the lower end of the bag. The beginner is apt to choose too long a handle and can then take only long, slow strokes, even if he does not get all mixed up with the vegetation and his fellow collectors. Three feet is long enough for a handle, especially if one handles well the two feet which are covered with shoes.

Fig. 1.—A young collector using a net.

The sweeping net should be made of stout white muslin or light duck on a strong rim well fastened to a handle of such a length that the user can just touch the ground with the rim of the net without stooping. The diameter of the net depends somewhat on the strength of the user and its depth may be from one and one half to two times its diameter. It is used to sweep blindly through grass, bunches of flowers, light bushes, etc., in a fairly certain expectation of getting something. Much of the material will be damaged by the rough handling, but it is the quickest way to get large numbers of specimens, and the only way to get certain things quickly. The tendency seems to be to make the handle of the sweep net too short, some on the market being only six inches long. These do not tire the arm so much as nets with longer handles, but you either miss the insects living near the ground or you get a very tired back. One useful trick in sweeping is to have a small cushion (about 2 by 1½ inches) of cotton covered with cheesecloth or muslin and a bottle of chloroform or ether. After sweeping for a few minutes moisten the cushion with the anesthetic, drop it into the net, and quickly twist up the bag so that the fumes are confined. In a short time even the liveliest grasshopper will be asleep and can be picked out and either saved or rejected. If rejected they will all shortly revive and walk, hop or fly away.

The third net of the complete outfit is the water net. The bag should be of some strong material through which the water will run readily. The rim should be strong and may be either circular in outline or flattened at the side opposite the handle. The advantage of the flattening is that the bottom of ponds can be skimmed, but the circular rim does fairly well, as the stirring of the water stirs up even the bottom insects, and they are caught in the return swish of the net. A great deal of mud and weeds will also be caught, but devices to prevent this, such as covering the mouth of the net with a coarse wire screen, does not work well in collecting insects. After clearing the net of mud as much as possible by washing it through the net, dump the rest on the bank, preferably in the sun. Some insects will probably be seen at once, others will appear as the mass dries out. After you think you have found everything, wait a while and look out for very small beetles. Many collectors miss them.

Many or most of the nets that are for sale have folding rims and jointed handles. Opinion differs as to the best. When lightness and ease of transportation is an object it is well to have but one handle and frame with interchangeable bags. The landing net used by fishermen, in which the frame consists of two pieces of flexible steel that lie close together when not in use, is excellent. The two-jointed handle is better than the three-jointed one, as one of the joints of the former is just right except for high flying or deep diving quarry. In these cases add the second.

A sieve is handy for getting the small insects hiding under accumulations of dead leaves, in moss, trash, etc. Two sieves with meshes of different size are handier. A good plan is to have a strong bag about a foot and one half square by two feet deep. About nine inches from the top sew pieces across the corners so that a piece of half-inch mesh wire screen rests on them. Sift through this until there is quite a bit of fine material in the bottom of the bag, and then retire to a comfortable place protected from the wind and spread a small sheet of white muslin or canvas. Now resift, using a mesh about four or five to an inch. The flat-bottomed sieves six or eight inches in diameter which are used for making French fried potatoes and the new wire pie pans are excellent. Sift a very thin layer on to the white cloth and examine carefully the coarse stuff for relatively large things before it is thrown away. Be patient with the small stuff. Insects have a habit of "playing possum" and have plenty of patience themselves. They do not seem to like tobacco smoke. If you do, blow some on the litter. It will hasten matters.

This is a good place to mention collecting forceps, as they are almost necessary in picking up very small insects as well as insects concerning whose ability and inclination to sting there may be some suspicion. The

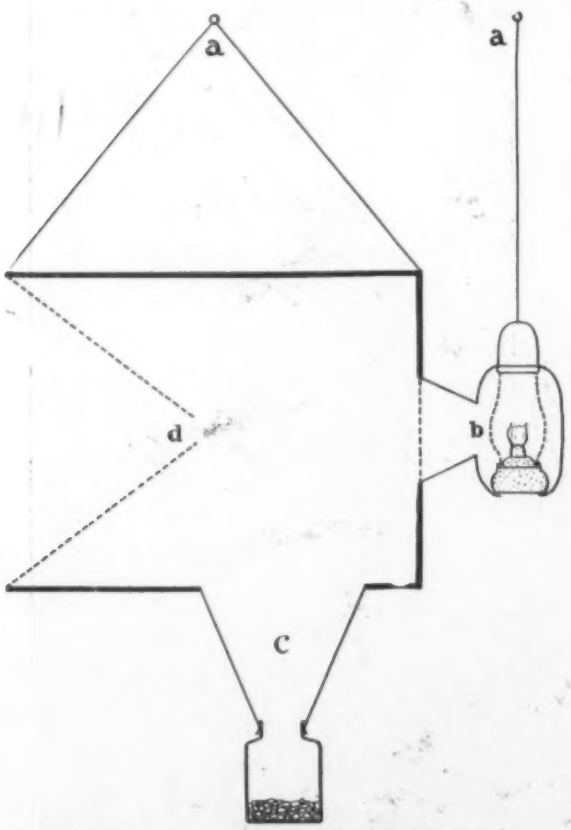


Fig. 2.—Diagrammatic section of a trap for insects which are attracted by light.

a, Supporting strings; *b*, lamp shut off from the trap by a glass plate or netting; *c*, canvas bag with cyanide bottle; *d*, glass plates or netting set at an angle. The space between the inner edges of *d* should be about one inch wide.

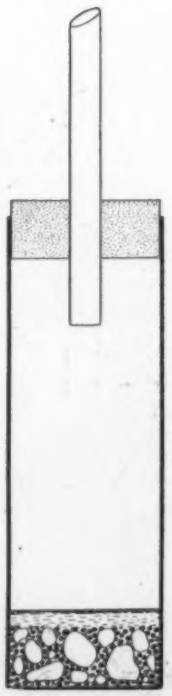


Fig. 3.—A collecting tube fitted with a quill for taking insects out of an umbrella.

best forceps for handling very delicate insects do not seem to be on the market. They are made of strips of German silver and have small but rounded points. However, the small steel ones which are on the market do very well. Steel forceps about a foot long are handy for picking caddice cases, etc., out of water, but they are of little use in general work. Dealers also carry forceps having gauze covered frames at the tips. They are meant for holding stinging insects while they are being examined, but they also are of very little use to the general collector.

A strong knife for cutting off galls, stripping bark, splitting infested branches, etc., is essential. A trowel is useful in following insect burrows, or digging for root borers. The entrenching tool used in the army is a handy all-around substitute for trowel, hatchet, and large knife combined.

There are two chief methods of night collecting in general use: sugaring and a light. Another, while not so productive of specimens, is more interesting. It consists in simply prowling around with an acetylene bicycle lamp examining the center of flowers, the underside of leaves, tree trunks, etc., to find out what the nocturnal insects are doing, and also where and how the day flying insects are passing the night.

Fig. 4.—A breeding cage.

The flower pot holds earth which contains a growing plant or a bottle with fresh twigs. The lantern globe with a netting cover confines the insects.

There are about as many receipts for making the sugar mixture as there are for "mother's biscuits." Baking molasses usually forms the basis. Some additions are any combination or all of stale beer, rum, asafœtida, and brown sugar. The mixture should spread easily but not run badly. It is to be applied before dusk on tree trunks, fence rails, and the like. Starting from some comfortable resting place as a base, lay out a circuitous route, "sugaring" something every few feet, and end at the resting place. After dark, if luck be good, the sugared strips will be full of moths, eagerly sipping the sweets. Several wide-mouthed cyanide killing bottles will be useful, but a net will be practically useless. It is well to have a little ether in each bottle, and do not put a moth in a bottle until its predecessors have stopped fluttering. Only experience will teach how to catch these moths with a bottle. Some fly upward when disturbed and some fly straight out or sideways, but the majority drop a few inches before flying, so when in doubt hold the bottle slightly below the prospective captive.

Light attracts many sorts of insects besides moths. Street and porch lights are fruitful hunting grounds. A lamp by an open window makes the room it is in a splendid trap, or a smaller one can be fixed up and put "in the field." Fig. 2 shows the principle. It is not difficult to make the box collapsible so that it can easily be transported. An ordinary barn lantern set in the center of a white sheet or a "bull's eye" throwing a light against a sheet hung over a fence or between trees does very well. In the latter cases a net will be desirable, but not easy to use. Both light and sugar work best where there is a variety of vegetation, as where woodland passes into swamp or where there is an abundance of second growth.

Many other sorts of traps have been devised. Olive bottles and fruit jars buried up to the neck in the ground and baited with molasses, meat, etc., are simple and effective. The insects caught in this way may be washed off in alcohol and will be nearly as good as new. Boards daubed on the under side with molasses or covering meat are not bad. Girdled branches and cut limbs hung up attract wood boring insects, which can then be collected by beating them into an upturned umbrella by sharply rapping the limbs with a stout stick. In fact, an umbrella is a very useful piece of apparatus. Branches, both living and dead, are full of insects. The inverted umbrella catches what are knocked off, but does not hold them for long. The collector must act quickly. Some collectors put a quill in the cork of a collecting tube as shown in Fig. 3. If the outer end of the quill be put over the insect it will crawl up through the quill and into the bottle, from which exit is difficult. If the umbrella be white, or at least lined with white, the insects can be more easily seen, but so can the collector—not by the insects particularly, but by inquisitive humans—and the non-committal black does very well.

Beating will knock down many larvæ. Directions for preserving them are given later on. Some, at least, should be reared, and here ingenuity is of more value than volumes of instructions. The beginner will doubtless be inclined to give his charges more light and air than is necessary. Pasteboard shoe boxes are excellent for large caterpillars. Tin boxes keep the food longer and are easily cleaned, but must be watched carefully or the food will mould. If the food plant can be potted, a good contrivance is to slip a lantern globe over it,

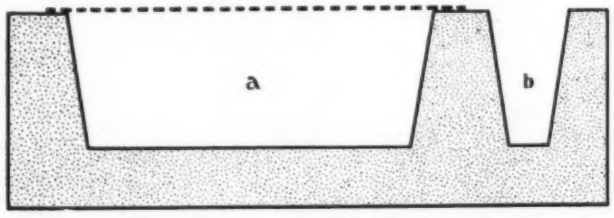


Fig. 5.—Section of a plaster breeding box. a, Space for insects; b, space for water.

sinking the bottom far enough in the ground to prevent the escape of larvæ in that direction and covering the top with cheesecloth. Even if the plant cannot be grown, twigs can be kept fresh for some time by keeping their cut ends in a small bottle of water sunk in the ground and used inside a lantern globe. (See Fig. 4.) The twigs will be held in place and larvæ prevented from drowning if cotton be loosely stuffed in the neck of the bottle around the twigs. It is well to throw a thin layer of dirt over the cotton so that fallen larvæ can easily get back to their food. A useful device for certain larvæ (not leaf eaters) is shown in Fig. 5. It is made of plaster of paris. The water at one end keeps the block moist. It is useful chiefly for ground-inhabiting larvæ or for galls. However, for the latter fruit jars with moist sand in the bottom or a moist sponge does just as well or better. Do not forget the larvæ living in hollow stems, dead wood, and under bark.

KILLING.

Up to this point but little mention has been made of killing insects, and that was not really necessary. Insects can be studied alive with great pleasure and profit. However, there are so many kinds (about 15,000 in the vicinity of New York city, for example), and the differences between species are often so minute that it is well to kill and preserve samples at least.

The best all-around killing agent for adult insects is cyanide of potassium. It should be broken into pieces varying in size from the size of a small pea to that of a hickory nut, according to the size of the bottle to be used. Olive bottles make good medium-sized bottles, while fruit jars are better for large sized moths and butterflies. Tubes even as small as ¼ inch in diameter by about 2 inches long are not too small for some things. Avoid bottles with strongly constricted necks. Avoid also bottles made of thin glass. There are many ways of keeping the cyanide in position and the bottle in good condition. The most general way is to pour a thin layer of plaster of paris over a layer (from ¼ to ¾ inch deep) of cyanide. However, since such a bottle will quickly get too moist from the specimens and the decomposition of the cyanide, some further device is almost always used. The pieces of cyanide may be wrapped in soft absorbent paper or imbedded in dry sawdust before the plaster is poured on. Another way is to imbed it in dry plaster before pouring on the wet. A piece of blotting paper should be fitted tightly over the plaster after it has "set." See Fig. 6. Some do not use plaster, but imbed the cyanide in cotton and cover this with a piece of blotting paper or a thin porous cork. A dangerous but otherwise fairly satisfactory method is to imbed a piece of cyanide on the inside surface of the cork and have none in the bottle itself. This bottle will be dry but not strong, and as the cork will in time become saturated with poison, it will be very dangerous. It is always well to have a few narrow strips of loose absorbent paper in the bottle. They prevent injury to the insects by shaking and help keep the bottle dry, as they can be frequently changed. As ordinarily made, a bottle should be allowed to ripen for several days before using. If wanted at once, put a few drops of vinegar or a pinch of boracic acid powder with the cyanide. Collectors of delicate moths and butterflies frequently put a few drops of ether or chloroform in their cyanide bottles before starting out. This is to quiet insects at once, for the cyanide sometimes kills slowly. Experience will teach the collector that some insects die very slowly and revive after apparent death. On the other hand, ether and chloroform make insects

Fig. 6.—Diagram of a cyanide killing bottle.

1, cork; 2, blotting paper; 3, plaster of paris; 4, pieces of cyanide in sawdust.

brittle, and too long an exposure to cyanide fumes changes the color of some insects.

Practically all beetles and dragon flies, together with dull colored, hairless insects of other orders, can be killed in alcohol and kept there indefinitely. Fifty per cent is strong enough for killing and 70 per cent for preserving. Higher grades make them brittle. No fly, bee, butterfly, moth, or any green insect other than previously mentioned should be put into alcohol. In an emergency, kerosene, gasoline, or benzine put on the thorax will kill and give satisfactory specimens. The thorax is the part of the body which bears the wings and legs. Insects breathe through holes in it and in the abdomen; not through the head. Pounded laurel leaves and peach pits make a weak killing agent, and butterflies and moths may be killed by carefully but firmly pinching the thorax between the thumb and finger, one on each side. In fact many collectors of these insects pinch their captures before taking them out of the net. This stops their injuring themselves by thrashing about.

(*To be concluded.*)

Anthropological Survey of Canada

THE Geological Survey of Canada has been conducting a number of interesting operations during the past season. In Nova Scotia, Harlan I. Smith has been making investigations of the shell heaps of Merigomish and important results are anticipated, as it is known that the country around the Gulf of St. Lawrence was formerly inhabited by no less than four totally different peoples. In southwestern Manitoba, W. B. Nickerson is continuing the explorations of the mounds, earthworks, and village sites; and W. J. Wintemberg is examining a section of the country between Prescott and Peterborough for a site of culture different from that of the Roebuck site where he excavated in 1912.

Air-Break Switches

(*Continued from first page.*)

switches tested consisted of one LG-9 110,000-volt General Electric switch, and three or four 44,000-volt air-break switches of different types. The tests, however, were not regarded as competitive between the different makes of switches, and were conducted mainly for the purpose of determining how different weather conditions affected the operation of air-break switches, and the effect on the lines and other equipment resulting from their use.

44,000-VOLT SWITCH TESTS.

Fig. 3 shows a one-line diagram of connections as made for the 44,000-volt switch tests. The power was taken from 550-kilowatt, two-phase, 60-cycle generators in the Dunlap station at 440 volts. This voltage was stepped up to three-phase 50,000 volts through two banks of Scott connected transformers, each bank consisting of two 550-kilowatt units. There was also available for use in connection with the oscillograph, a spare 50,000/440-volt, 550-kilowatt transformer which made it possible to take the voltage curve of the oscillograph record from the high tension side of the power transformers. There was placed in the circuit on the power side of the switch a 50,000-volt 10 to 1 current transformer which was connected to one of the other oscillograph vibrators for recording the current wave. The third vibrator of the instrument was connected to the load side of the switch through suitable potential transformers, but could only be used when that part of the line to which these transformers were connected furnished part of the artificial loading, which was not the case in all of the tests.

As previously stated, the artificial load consisted of the charging current on the high tension lines of the Georgia Railway & Power Company between Tallulah Falls and Atlanta, the tests being conducted after midnight. The lines are constructed of 4/0 stranded copper spaced 9 feet vertically and insulated for 110,000 volts. The distance from Tallulah to Atlanta is approximately 90 miles, the Dunlap station at Gainesville being about midway between. There is a tie switch between the two lines, known as the north and the south lines, at this station with sectionalizing switches on both lines on both sides of the station, so that the lines can be easily separated into four different sections right on the grounds where the tests were conducted. Each of these sections of about 45 miles in length furnished approximately 7 amperes charging current at 50,000 volts, making the maximum load with all four sections cut in, 28 amperes, or about 2400-kv-a. of leading power-factor. These four sections, together representing a total of 180 miles, imposed rather a severe load on a 44,000-volt air-break switch. It is not often that power is transmitted so great a distance at this voltage, and an air-break switch of this rating would probably never be called upon to open a circuit of this length.

A water rheostat was rigged up in the field for furnishing a true energy load, and although rather crude in construction, served the purpose admirably, drawing as high as 50 amperes in some of the tests. (See Fig. 2.)

In order to get a better check on the voltage surge set up on the load side when opening the circuit with an air-break switch, a needle point spark gap was connected between two of the phases, set accurately for different voltages, and the maximum sparking distance noted for each switch under the same load conditions. The same experiment was tried with an oil-break switch in the circuit, and the maximum sparking distance recorded when the circuit was opened with this switch was greater than with the air-break switch.

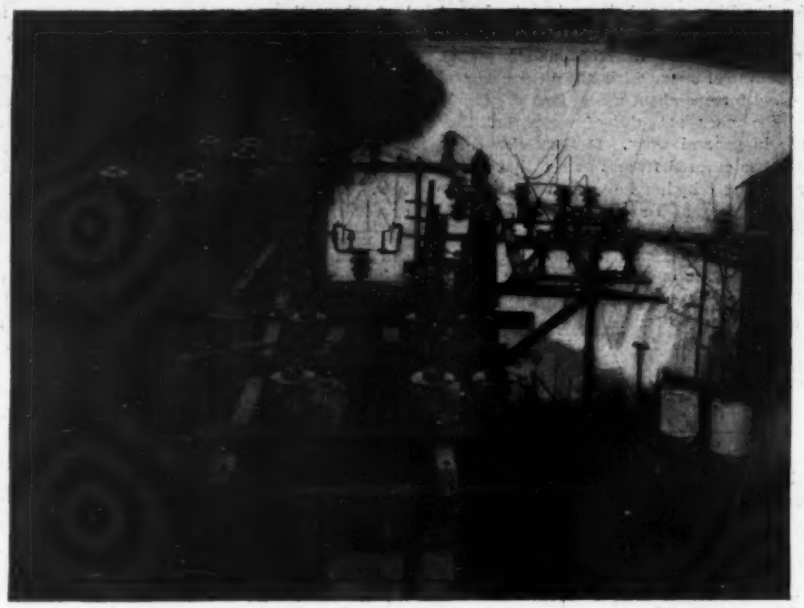


Fig. 1.—General view of switch structure.

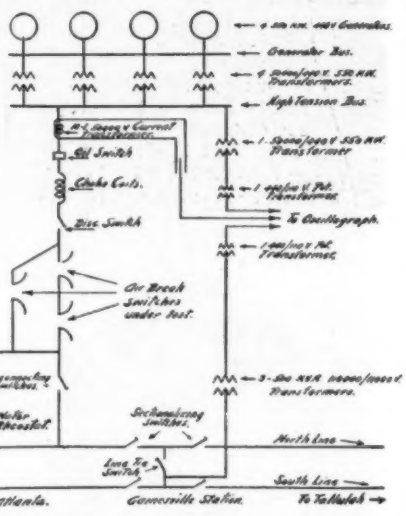


Fig. 3.—One-line wiring diagram for 44,000-volt switch tests.

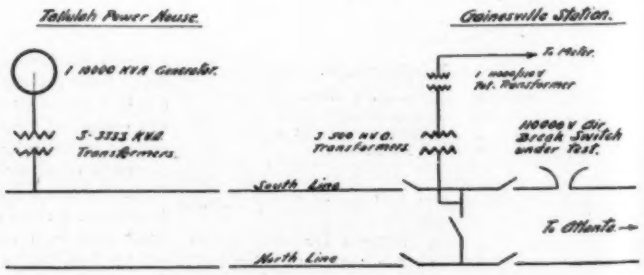


Fig. 4.—One-line wiring diagram for 110,000-volt switch tests.

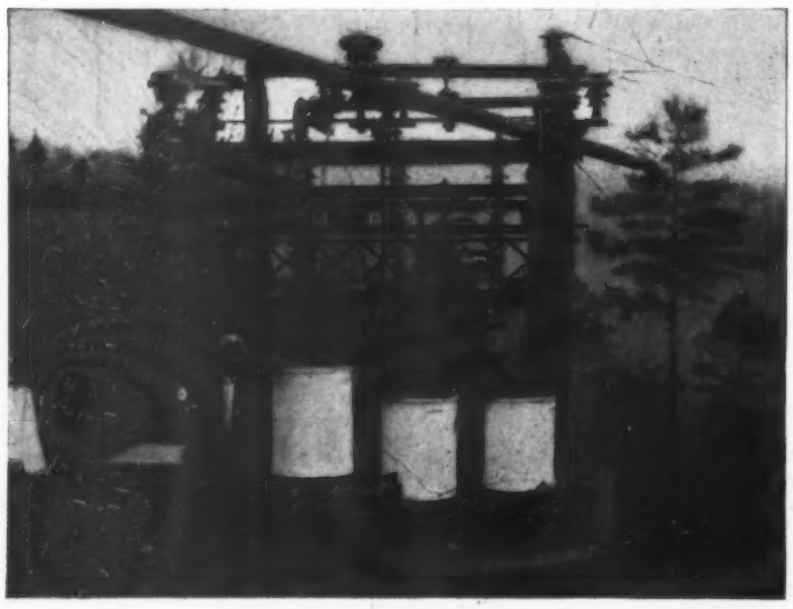


Fig. 2.—Water rheostat.

110,000-VOLT TESTS.

In Fig. 4 is shown the wiring diagram for connections as made for the 110,000-volt switch tests. The power was taken from one 10,000-kv-a. generator at the Tallulah Falls power house and stepped up through one bank of three 3333-kv-a. transformers delta-Y connected. The switch was connected in the south line at the Gainesville station, as shown in the diagram, and opened under line voltage varying from 65,000 to 120,000, the charging current varying from about 18 to 29 amperes, these readings being taken at the power house. These figures cor-

Fig. 6.—Oscillogram made at the time of interrupting a 3,000 kv-a. load at 50,000 volts by a 44,000-volt air-break switch.

Fig. 8.—An Oscillogram made at the time of interrupting a 1,720 kv-a. charging current by an oil switch.

Fig. 7.—An oscillogram made at the time of interrupting an energy load of 2,500 kv-a. with an air-break switch.

50,000 volts, 650 kv-a.

50,000 volts, 1,700 kv-a.

50,000 volts, 2,400 kv-a.

112,000 volts, 5,230 kv-a. c.c. load.

Fig. 5.—Photographs of arcs rising from air-break switches under the loads indicated in the oscillograms illustrated.

respond to a kv-a. load of from 2000 to 6000, only half of which was actually interrupted by the switch on account of its location at the mid point of the line.

OSCILLOGRAPH RECORDS.

In Fig. 6 is shown one of the oscillograph records obtained while interrupting a load of 3,000 kv-a. at 50,000 volts with one of the 44,000-volt switches, the time required to break the arc being three seconds. The upper curve is the voltage curve on the power side of the switch and the lower one the current on the same side. The load was a true energy load obtained by means of the water rheostat.

Fig. 7 shows a record obtained while breaking a true energy load of 2,500 kv-a. with a different make of air-break switch, the time necessary in this case being the same as in the previous one. The upper curve is again the voltage curve on the power side of the switch and the lower one the current.

Fig. 8 shows, for comparison with the foregoing records, a record obtained while interrupting a charging current load of 1,720 kv-a. with an oil switch, the voltage and current curves occupying the same relative position as in the records already referred to.

Figs. 9 and 10 are records obtained when opening charging current loads of about 1,250 kv-a. with two different makes of air-break switches, the upper curve being the voltage, the middle one the current on the power side of the switch, and the bottom one the voltage on the load side.

The remaining cuts shown herewith are actual photographs of the arcs which resulted when opening the circuits under the loads indicated, an explanation of which is hardly necessary.

GENERAL CONCLUSIONS.

Complete records were kept of the load and weather conditions of each test, and the actual time in seconds required to break the arc, with a short description of its behavior. The space necessarily forbids the publication of these notes, but several conclusions have been drawn from a careful study of them.

The maximum time necessary in which to interrupt the arc in any of the 50,000-volt tests was 25 seconds and the minimum 2 seconds, the average time for a large number of the tests being 6 seconds. This time period depends more on the weather conditions, especially as regards the velocity of the wind, than the kv-a. load on the lines, this statement being substantiated by the fact that in one series of tests with a certain kv-a. load on the lines, the average time required to break the arcs was much less than the average time in another series under different weather conditions when the kv-a. load was smaller. The average time necessary to interrupt the arcs in the 110,000-volt tests was 7 seconds, the maximum being 16 and the minimum 3.

This means that the air-break switch requires anywhere from 120 to 1,500 cycles in which to interrupt a circuit, while the oil switch may accomplish this result in half a cycle. This time element in the case of the air-break switch produces an effect on the lines similar to a series of light hammer blows, and these blows, although probably not so violent as the one caused by an oil switch, must nevertheless have a damaging effect on the insulation.

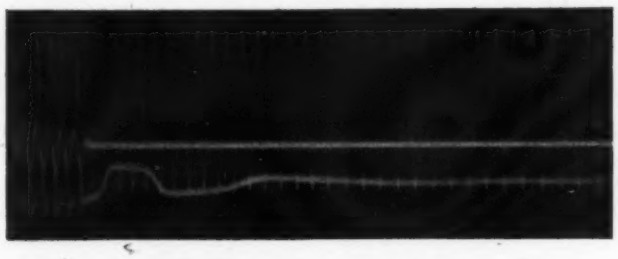


Fig. 9.—An oscillogram made at the time of interrupting a 1,250 kv-a. charging current by an air-break switch.

The rating given air-break switches by the manufacturers is more or less arbitrary. The spacing adopted, especially as regards the distance between phases, is however not sufficient, as the lines are easily short circuited by the arcs lapping between the phases. The distance between phases for a 44,000-volt switch should be 6 or 7 feet, and for a 110,000-volt switch certainly not less than 10 feet. The switches tested were spaced 4, 5, 8 and 10 feet, and in many of the tests the arcs lapped between the phases, as shown in some of the photographs. Great care must be exercised in wiring up the switches to prevent the arcs of one phase from lapping the leads to some other phase. In other cases, the arcs are blown directly downward, and this means that the switch must be properly spaced from the frame or steel structure on which it is mounted to prevent the arcs grounding the lines. The large amount of space necessary for the installation of air-break switches because of the foregoing precautions which must be taken is a serious drawback to their use.

It may be safe to advance the opinion that the proper design of an air-break switch involves a mechanical movement which will assist in drawing the arcs up the horns, as the heat of the high voltage arcs alone is sufficient to accomplish this only in a very still atmosphere. With the slightest breeze blowing the arcs sometimes hold to one point of the horns for many seconds before exhibiting any tendency to rise. In one of the switches tested, advantage was taken of this point in the mechanical design, and this switch broke the arcs much more readily than the others.

It was found that a true energy current is more easily interrupted than a charging current of the same kv-a. value under the same weather conditions, and that under

Fig. 10.—An oscillogram made under similar conditions to those prevailing in Fig. 9, except another air-break switch was used.

light loads, high winds materially aid in breaking the arcs, sweeping them from the horns soon after their formation. With heavier loads, or lower winds, however, the arcs lap between phases with the spacing used in these tests before they are blown from the horns.

The oscillograph records obtained during these tests do not indicate that there is any high frequency set up on the lines by air-break switches which is especially dangerous to the equipment. It is possible, however, that the oscillograph does not show such oscillations, and these records cannot be relied upon to establish this fact conclusively. The spark gap test previously referred to in this article would indicate that the surges in the voltage set up by the air-break switch are not so violent as those set up by an oil switch, although this statement is not in line with the current opinion.

The general conclusion drawn from these tests is that the air-break switch will doubtless replace the oil switch for many uses, such as sectionalizing short lines, cutting in and out equipment only occasionally used, for emergency use, etc.; but where frequent switching is necessary and the time element in breaking the circuit of consequence, the air-break switch in its present stage of development would hardly prove satisfactory.

The Origin of the Word "Engineer"*

Its Etymology and Applications Considered

By Hunter McDonald

I HAVE been tempted to delve somewhat deeper into the origin and present meaning of the word "engineer" than my predecessors in office have done. Realizing my own lack of fitness for the task, as far as the origin is concerned, I called in a specialist on etymology, Dr. Bert E. Young, professor of Romance Languages of Vanderbilt University, and lately honored by the French government with the decoration of Officer of Public Instruction for distinguished services in the promotion of French literature.

I quote his statement in full:

"I take pleasure in furnishing the best information I have as to the origin of the word 'engineer':

"'Engineer,' formerly 'enginer,' or sometimes 'ingeneer,' Middle English 'engyneour,' from the Old French 'engignier' or 'engigneour,' or shorter 'engineur.' This from Middle Latin 'ingeniarius,' one who makes or uses an engine, especially a war engine. 'Engine' is from Latin 'ingenium,' an invention, an engine.

"The French word 'ingenieur,' a semi-learned form, seems to come down by a slightly different road, being from the hypothetical Middle Latin word 'ingeniator' from 'ingeniare' from 'ingenium,' an engine. Or else the Modern French 'ingenieur' is an alteration of the better form 'engigneur,' mentioned in first paragraph.

"'Genie,' from Lat. 'genius,' orig. a spirit, extended as a term of war to the sense of 'art' of attacking or defending fortified places, etc., and then to the arm of the service devoted to military or naval engineering.

"'Ingenuity' from French 'ingenuite' from Lat. 'ingenuita' (t) s from 'ingenuus,' native born of free parents, frank, generous. 'Ingenious' from Lat. 'ingeniosus,' gifted with genius or natural capacity. Lat. 'ingenium' from Old Latin 'genere.'

"Apparently all go back to the ubiquitous root, 'gen,' to bear, to produce, to give birth to.

"Misc. remarks:

"Considering the derivation of ingenuity, there must have been confusion of Lat. 'ingenuus' and Lat. 'ingeniosus.' These should be almost opposite in meaning. I suppose an 'engineer' ought to be both 'ingenious' and 'ingenuous,' artful and artless, sophisticated and unsophisticated, bond and free. According to the above, I should say that the man who pronounces 'injine' is only atavistic.

"Ex.—'In hys court was a false traytoure, that was a grete Yngynore (plotter). (Halliwell, 1420).'

"Ex.—'The most prime Engineers of Oaths that ever the world knew. (Butler, 1680).'

"Ex.—'For 'tis the sport to have the engineer hoist with his own petar. (Shak., 1602, Ham, iii, 4, 206).'

"Ex.—'The Ingener of this practice—was a Portugal. (Carew, 1620).'"

From the Oxford Dictionary, which no doubt gives the prevailing English view, I have extracted the following definitions and examples of the use of the word "Engineer."

"One who contrives, designs, or invents. Ex. 1611, Rich, Honest age, 1844 (36) 'Yet you cannot deny them to be the devil's engineers.'

"1635, R. Gibbs in Spurgeon 'That great engineer Satan.'

"A constructor of military engines (Obsolete). One who designs and constructs military works for attack or defense. 1325 Coer De Leon 1387—'a tour ful strong, that queyntyly engynours made.'

"A soldier belonging to the division of the army called engineers, composed of men trained in engineering work. Ex., Porter's History, Royal Engineers. 'This day (May 26th, 1716) may thereafter be taken as the one on which the engineer branch blossomed into a distinct corps.'

"One whose profession is the designing and constructing of works of public utility, such as bridges, roads, canals, railways, harbors, drainage works, gas and water works. From the eighteenth century, also civil engineers (from the military).

"Ex. 1792 Smeaton Reports (1797) I pref. 7. 'The first meeting of this new constitution, the Society of Civil Engineers, was held on April 15th, 1793.' Ex. Eddyston L. introduction—'My profession of a civil engineer.'

"A contriver or maker of engines (specially mechanical engineer.)

"One who has charge of a steam engine. In England only with reference to marine engines. In the United States often applied to the driver of a locomotive. Ex. 1860, Bartlett's Dictionary. American, engineering, 'the engine-driver on our railroads is thus grandiloquently designated.'

"Engineman, one who works or helps to work a fire engine. One who attends to a stationary engine. The driver of a locomotive."

From other English authorities:

March's Thesaurus Dictionary. "One versed in any branch of engineering. To manage skillfully. The science and art of building, making, and using engines and machines."

Hallowell's archaic and provincial words. "Engin, wit, contrivance (Lat.) Inginous, inventive (Johnson)."

From Joseph Wright's Dialect Dictionary. "In 1649 Gray wrote 'Master Beaumont a gentleman of great ingenuity and rare parts adventured into our mines, who brought with him many rare engins. The memory of these 'rare engines' survives in the name of the seam which he appears to have discovered, still called the engin seam." It will be noted that Beaumont was practising civil engineering at quite an early date.

From the Century Dictionary, presenting the American view, the following:

"A person skilled in the principles and practice of any department of engineering. Engineers are classified according to the particular business pursued by them, as 'military,' 'naval' or 'marine,' 'civil,' 'mining,' 'mechanical,' and 'electrical' engineers.

"To work upon; ply; try some scheme or plan upon.

"Ex.—'Unless we engineered him with question after question, we could get nothing out of him.'—Cowper.

"To guide or manage by ingenuity or tact; conduct through or over obstacles by contrivance or effort; as to 'engineer' a bill through Congress."

Through the kindness of our secretary, Mr. Hunt, I have been able to secure the following translations from the Dictionnaire de la Langue Française:

"One who plans, lays out and directs field work and fortifications, for attacking, defending, or fortifying places.

"Ex.—'Then he (Peter the Great) has had even a school of engineers in a country where no one (before him) knew the elements of geometry, Volt. Charles XII I.'

"One who directs [private] works or public works, such as the construction and maintenance of roads and bridges, working of mines, etc. Engineer of bridges and roads. Mining engineer, naval engineer, or marine engineer, railroad engineer.

"Civil engineer, name given to engineers who are not trained in technical schools or who work for private industry.

"Naval architect or engineer, one who applies himself to the art of naval construction.

"Topographical engineer, one who draws maps. Hydrographical engineer, see hydrography.

"Engineer for mathematical instruments, one who makes mathematical instruments."

Also, from Cotgrave's Dictionary of the French and English tongue:

"Enginier.—An engineer; a maker of engins.

"Enginer.—Engigner.

"Engigner.—A deceiver, beguiler, cousener; also an enchanter.

"Engin.—An engine, toole, instrument; also understanding, policie, reach of wit; also suttletie, fraud, craft, wilines, deceit.

"Ingenieur.—An enginer, engine-maker; fortifier."

Mr. Hunt also furnished me the following translation from Grimm's Deutsches Wörterbuch:

"Engineer, n.—This word of the present day, for military architect, surveyor, introduced from a foreign language in the seventeenth century, represented an artful calculating person in general. Ex.—'He who wishes to bring Germans into an understanding must be a very good and wise engineer (schemer, calculator).' Weidner's, Zinkgres, 3, 158."

No trace of the use of the word "engineer," or of any of the words from which it is derived in describing the building of any of the ancient structures has been found. That engineers of great skill existed is evidenced by monumental and written records, but they were designated otherwise, as, for example: Frontinus, in his water supply of the City of Rome, as translated by Clemens Herschel, M.Am.Soc.C.E., mentions "modull" (levelers), "scientia" (builders), "agrimensores" and "geometricii" (land surveyors), "architectos" (architects), and "Curator Aquarum" (Commissioner of Waterworks), but none of the Latin words from which the word "engineer" is derived are used in connection with the process of building or maintaining. The conclusion is inevitable that the name at least is comparatively modern, and that the attempt to class the calling among the learned professions is still more so.

John Smeaton was the first engineer to style himself civil engineer (probably in 1782).[1]

In the annual address of Mr. Charles Hawksley, president of the Institution of Civil Engineers, 1901, an extensive quotation is made from the report of the council for the session 1885-86. A portion only is repeated here:

"'The honor of having originated the institution is often assigned to Smeaton, or to Telford, but the idea is erroneous in both cases. Smeaton died many years before it was thought of, and Telford only joined it after its establishment.'

"A society of engineers, still existing, was founded by Smeaton in 1771; it includes many of the most eminent members of the profession, but it is rather of the nature of a social club than of a scientific association, and has no connection with this institution."

To those who are interested in the beginnings of engineering, I would recommend an examination of the two papers above referred to and the following: Annual addresses of Past-Presidents William E. Worthen, 1877 ("Transactions," Vol. XVII), and William P. Shinn, 1890 ("Transactions," Vol. XXII), also of Charles B. Vignoles, F.R.S., past-president, Institution of Civil Engineers, 1870 ("Minutes of Proceedings," Vol. XXIX).

On page 604, of *Engineering News*, May 26th, 1910, is an entertaining paper, entitled the "Origin and History of the Profession of Civil Engineering." A footnote describing it reads as follows:

"An appendix to the presidential address of James C. Inglis, president of the Institution of Civil Engineers of Great Britain. Abridged from the account contained in the life of Sir William Fairbairn by the late Dr. William Pole, F.R.S., secretary of the institution."

A portion of the beginning is quoted:

"The root of both the words, engineer and engine, is found in the Sanscrit 'jan,' to be born, from which came the Greek form γεν, and the Latin 'gen,' the latter being embodied in the old verb 'genere,' with its compound "ingenere" (changed into ingignere), to implant by birth, and in their later substantive 'ingenium,' an innate or natural quality.

"The old Latin verbs, 'genere' and 'ingenere,' gave rise to the French form, also a verb, 's'ingenier.' This is of great antiquity, and from its comprehensive and useful meaning it has continued in use down to the present time, being found continually in modern French writings. The import of it has nothing whatever to do with engines or machines, but is purely psychological. It is given in Littre's great French dictionary:

"'Chercher dans son genie, dans son esprit, quelque moyen pour reussir.'

* From the Presidential Address at the recent Annual Convention of the American Society of Civil Engineers.

[1] See discussion by Clemens Herschel, M.Am.Soc.C.E., of Paper No. 472, entitled "Beginnings of Engineering," by the late J. E. Watkins, Assoc.Am.Soc.C.E., "Transactions" Am. Soc.C.E., vol. xxiv, p. 382.

"Now, all authorities, including our own great Lexicographer, agree that this word is the true origin of the word 'engineer,' and thus we arrive at the interesting and certainly little-known fact that an engineer is, according to the strict derivation of the term, not necessarily a person who has to do with engines, but anyone who seeks in his mind, who sets his mental power in action, in order to discover or devise some means of succeeding in a difficult task he may have to perform."

There are sufficient divergences of authority and definitions in the above quotations to give room for any amount of argument.

These matters are mentioned primarily as leading up to a consideration of the condition in which the profession in this country now finds itself. There is ample evidence that the word "engineer" is now applied alike to the designers of engineering works and to the operators of engines. It is also evident that civil engineering is now considered by many to be a branch of engineering. In the language of the late Grover Cleveland, "It is a condition, and not a theory, which confronts us." We could not, if we desired, compel the public to call locomotive engineers "enginemen" or "engine-drivers," nor stationary engineers "power superintendents," notwithstanding the fact that such they are. President Worthen, in the address above referred to, says: "I would drop the term 'civil' as embracing too large a profession, and adopt prefixes, as military, hydraulic, railway, mechanical, steam, electric, and other divisions, when these are adopted as specialties." His idea seems to have been merely to divide civil engineers into different classes. He does not mention civil engineers as one of the classes.

Until recently I have also been inclined to the view that we should drop the word "civil" from the name of our society; but a closer study of the matter confirms me in the opinion that we should retain it. I think there can be no question but that civil engineering embraces all engineering except that connected with the actual conduct of war. The fact that the military engineer "in piping times of peace" performs the work of the civil engineer constitutes no distinction.

Two Phenomena That Are Still Mysteries*

Spontaneous Ionization and Penetrating Radiation.

Air is generally believed to be an insulator, electrically speaking, and it has been taught that dry air is a perfect insulator. In reality, however, it loses this property under certain conditions like the ultra-violet ray, the Roentgen ray and the influence of radio-active bodies. Changes are here evident that affect charged corpuscles—some negative and some positive—to which the name ions has been given. When these are attracted by conductors of opposite sign placed in their vicinity the ions abandon their charges to the conductors on contact.

Thus the air and gases in general become conductors when they are ionized. Further, the ionization of a gaseous mass abandoned to itself generally disappears quite rapidly when the ionizing cause, ultra-violet, radium rays, X-rays, etc., ceases to act. The ions of opposite charge combine to form a neutral particle, or coming into contact with the walls of the receiver containing the gas give up their charges. Such conditions are those of prediction and in a general way have been verified by experiment.

But when it comes to precise measurements it has been recognized that gas or air, hermetically sealed in a closed receptacle, preserves its conductivity, feeble but very appreciable, and this, far from disappearing, slowly increases up to a certain limit-value, reached in several days. After this it remains constant. This fact, discovered at about the same time (1890) by Geitel and Wilson, has puzzled physicists and to such a degree that, not finding any known cause, it has been quoted as the manifestation of a new property of matter, spontaneous ionization, whereby the ions take birth spontaneously in the midst of a gaseous mass, and this indefinitely.

But in reality there need be but little difficulty in finding out the probable causes of ionization if the precautions taken have been most minute. First of all, bodies of gas are likely to have in them traces of emanations from radio-active substances (radium, thorium, actinium, etc.) and in introducing gas into a receiver these emanations go with it and are causes for the production of ions. Also the walls of vessels that have been exposed to the free air, before experimenting, are probably covered with a deposit of radio-active substances, which, in being dissipated, make the gas a conductor. The walls of the container may further exercise an action of their own, which depends on their nature and on the impurities they contain. Such action (of impurities) would be at the maximum for lead and tin, at the minimum for aluminium and zinc and feeble for iron. Thus the ionization of gas within a receptacle may be influenced by the content of the exterior medium, by Roentgen rays and similar ones, and by the gamma rays of radium, which can traverse the walls and produce their effect within them. These rays are very penetrating, and there are few obstacles that will really stop them. They may, however, be excluded by screens of lead, and if one will experiment by inclosing the receptacle in screens of increasing thickness there will be observable progressive diminution of ionization down to a value which does not diminish even with greater thickness of the screen.

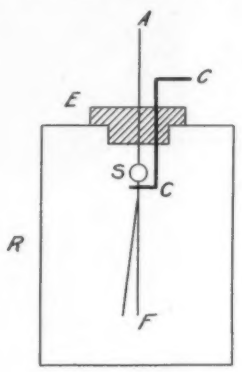
It is necessary, in getting at the truth, to eliminate successively all such sources of ionization, and to learn whether in their absence there will still exist traces of this kind of activity.

To cleanse internal surfaces properly sandpapering is efficient, together with washing with hydrochloric acid, water and ammonia and alcohol, and the radio-active deposits will have disappeared. A slow filtration of the air, as admitted through absorbent cotton or other porous material, will keep out emanations. As for the receptacles, while it is quite probable that lead will contain radio-active impurities, there seem to be no reasons for questioning most other metals, notably aluminium and zinc. Of the latter many samples tested have shown reasonably uniform quality measured by the ionization that goes on within them. With the quality of the material of the receptacle assured, radiations from the outside may be stopped by adequate screens of metal opaque to the radiations.

When all this is done, and all precautions taken, the fact remains that there still exists a residual, permanent ionization of a value of about half that which would be observed with the same receptacle cleansed and filled with inactive air and left unprotected by screens.

This leads us to the consideration of the method of measuring. The conductivity in closed receptacles is always very weak in comparison with the conductivity of free air, which is itself small when referred to the values obtained for the ionization of gas in the laboratories. It is therefore necessary to have recourse to a very sensitive electroscope of small capacity, so disposed as to avoid losses through the conductivity of supports or the effects of exterior electrostatic action. It is necessary further to work with a voltage sufficient to maintain the current to saturation throughout the measures.

The first observers measured the conductivity of the gas by the loss of charge per unit of time, indicated by a very sensitive electroscope placed within the receptacle, which was itself grounded. From the known capacity



Simple electroscope.

of the electroscope, and the variation in potential during a given time, the quantity of electricity dissipated can be deduced, and therefrom the corresponding number of ions.

The figure shows one of these arrangements, an electroscope with gold or aluminium leaf which is repelled from the vertical plate, *F*. The device is held in place within the receptacle by the wire *A*, which passes through a disk of ebonite, *E*, and is insulated by terminating in a button of sulphur, *S*. The electroscope is charged by means of the bent wire, *C*, which may be turned in the ebonite cork so as to make or break contact with *F*.

Apparatus of greater precision may be made, but it is not the purpose of this article to discuss it. The suggestion here is sufficient to present the principle.

Passing to the consideration of the principal results of which these delicate measures permit the establishment, estimates have been made of the number of ions originating per second in a cubic centimeter of gas. It should be remembered that the charge of each ion is supposedly equal to an elementary charge of electricity, 4.5×10^{-10} electrostatic unit C. G. S.

A physicist, H. L. Cook, working with a composite receptacle of about one liter capacity, the walls of which had been carefully cleansed, observed 11.3 ions per cubic centimeter per second. But by surrounding the receptacle with a lead envelope sufficiently thick the number of ions was reduced to 7.5. The excess, 3.8, is the number intercepted by the lead screen in the second experiment. Another observer, McLennan, experimented in the laboratory of the University of Toronto, near Lake Ontario. The measures made above the lake have always given smaller values, the water, like the lead, seeming to act as a screen to the mysterious rays which have been called penetrating radiation. Under the most favorable conditions, with a zinc receiver well cleansed, and with the elimination of the effect of the soil by the waters of the lake, the product of ions in the receptacle may be reduced to 4.5.

More recently still two scientists, Simpson and Wright, during a voyage from England to New Zealand, made a series of interesting observations. In the open ocean, distant from the shores, the production of ions was quite uniform, varying from 6 to 7, with the mean number 6.3. This was always smaller than the count upon land. To emphasize the difference, the counts obtained in Africa may be quoted. During a stop at Cape Colony a trip was made into the interior and at Matjesfontein a number of measurements gave a value of 12.3 or 6 more ions than that on the sea. The number 6 represents the penetration effect of the soil or land radiation, if one assumes that of the vessel and the sea to be zero. These observations show that ionization was always stronger near the coasts where it was about 9 ions while it regained its minimum of 6 only after the ship had been for a considerable time at sea.

From all these observations and investigations there are to be reached two general conclusions; first, that exteriors send rays capable of traversing the walls of receptacles, and such radiation can be eliminated only by using precautions which reduce the product of ions to about 6 per cubic centimeter. These rays constitute what may be termed penetrating radiation. In addition, even when the known causes of ionization have all been eliminated the ionization of gas in a closed receptacle does not cease, but remains at about 4 ions. The residual ionization may be termed spontaneous.

Whence comes the penetrating radiation? Examining the radio-active substances which exist in traces in suspension in the atmosphere, a profound investigation shows that they can account for no more than 0.1 to 0.2 ion per second. They do not suffice to account for the cause of the effect observed. Considering also the deposits of radio-active substances in their effect on the atmosphere, this is as variable as the deposits themselves. They might account for regular or accidental variations in the receptacles, but only of the order of 1 to 2 ions.

Finally one must consider a radiation of the soil itself in its superficial layers, with an intensity probably variable within fairly wide limits and which might correspond to 4 or 5 ions. Research has been made also as to whether the penetrating effect might not be due to radiation of cosmic origin. It is possible that such radiation exists but it does not seem necessary to invoke it to explain phenomena very near the earth's surface. It might intervene to effect ionization of high strata of the atmosphere, but even if observation had shown its existence, it may very well be left to one side for the present.

To what origin may one then attribute the spontaneous ionization that manifests itself in closed vessels, even after extreme precautions have been taken to insulate against all external radiations? There has been suggested a hypothesis of a sort of spontaneous rupture of several molecules, which, in exploding, project outside of themselves the electrons that they usually inclose. Such a hypothesis would suggest that heavy gases, the molecules of which contain a great number of electrons, ought in consequence to be more unstable and give greater amounts of ionization in the closed receptacle. It is true that while this suggestion does not come under the rating of improbable it does not seem to carry much weight. One may easily make other explanations, as for example that of Wood and Campbell, which supposes that all metals are in some degree radio-active. It would cause no astonishment to find the phenomena within the receptacle whose walls are themselves radio-active. But this again does not seem to take with the physicists, even with the extension of radio-activity to such substances as potassium and rubidium.

Under the circumstances, why not confess our ignorance and wait until decisive experiments elucidate this question, which is filled with interest despite its obscurity?

* A. Boutaric, University Montpellier, in *Cosmos*.

Railway Signals.

From the reports of the Interstate Commerce Commission it appears there are 8,312 block signal stations in the United States, of which 1,170 are operated by power. In these stations there are 142,122 operating levers, making an average of 17 levers to each station. In the operation of these stations it is recorded that last year 55,428 running signals were given, 28,969 switching signals, 3,157 "other signals." There were also made 42,011 switch movements and 27,291 derails set.

The Dawn Man of Piltdown

Was He One of the Missing Links?

THE fossil human remains discovered several years ago at Piltdown Common, near Fletching, Sussex, England, have continued to give rise to considerable controversy which has taken several directions. Of first importance is the question of the age of these remains, and in considering this the suggestion that has been made that there was anything in the nature of a "plant," or a hoax may be disregarded in view of the circumstances of the discovery, but this apparently does not preclude the fact that these remains, really belonging to a much later period, may have accidentally reached the place where they were found; and the fact that there were no traces of any of the larger, and more substantial and durable portions of the skeleton, appears to have been entirely overlooked, although stress is laid on the presence of "eoliths," which this individual might have used as tools.

Another point of controversy is as to whether the

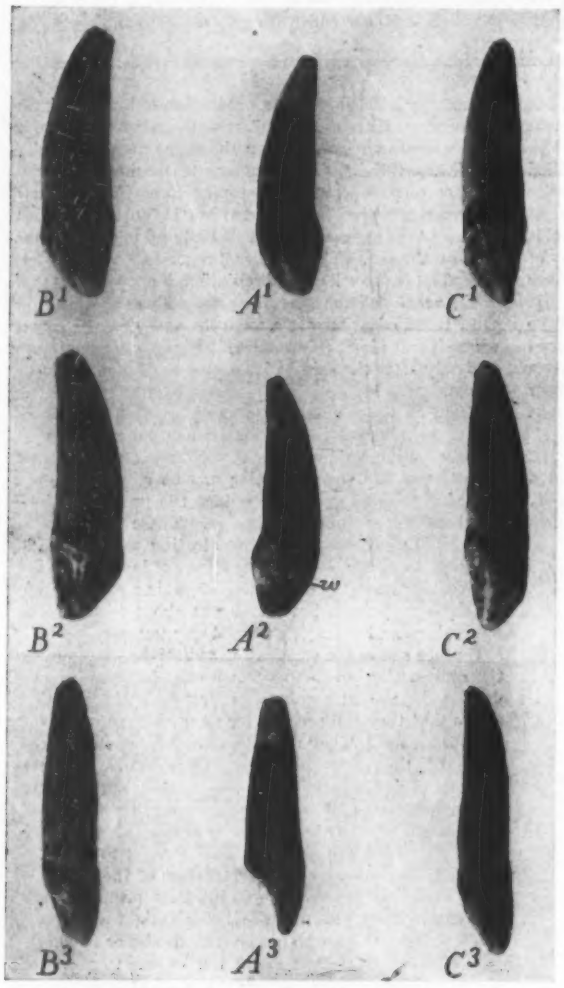


Fig. 6.—Canine tooth (cast) of the Piltdown man.

(*A*) in comparison with the left upper (*B*) and right lower (*C*) canines of a female orang. Natural size. The lower canine is turned upside down to facilitate comparison with the others. In *A* the tip of the root is restored. A^1, B^1, C^1, seen from the outer or labial side. A^2, B^2, C^2, seen from the inner or lingual side. *w*, worn surface. A^3, B^3, C^3, seen from the front, or antero-internally.

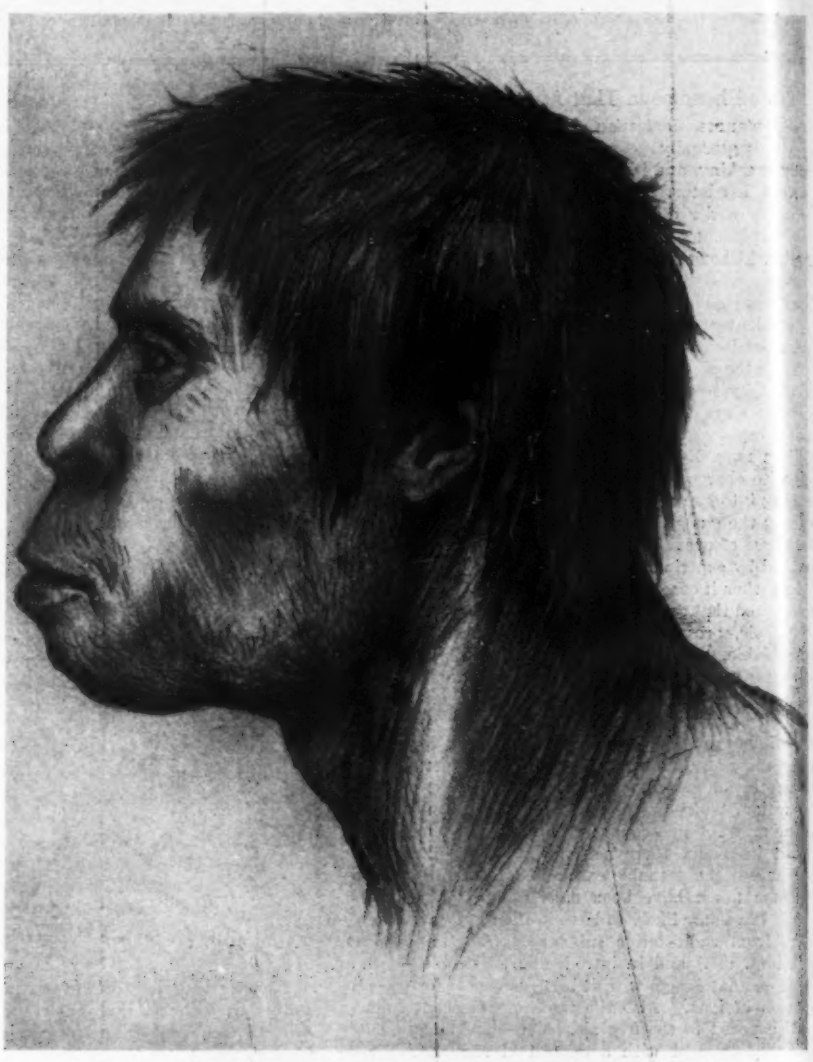


Fig. 1.—The Piltdown man in life. A restoration by Prof. J. H. McGregor.

Fig. 2.—Model of the Piltdown skull as reconstructed by Dr. Smith Woodward.

Seen from the left side; one half natural size. Williams Collection, American Museum. The dark areas represent the portions preserved in the original fossil; the light areas are restored. The lower jaw (except the front part) is restored from the opposite side.

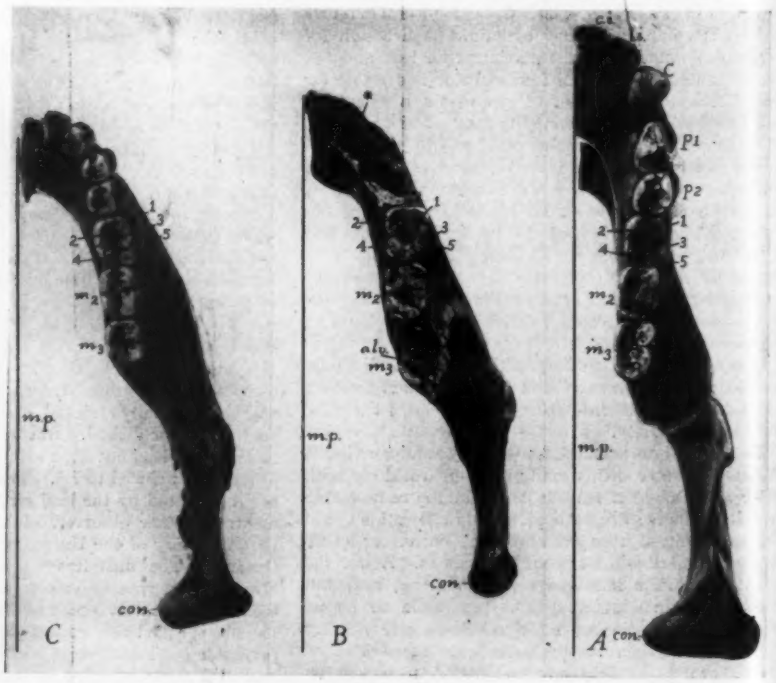


Fig. 5.—The same three specimens of Figs. 3 and 4, viewed from above.

Abbreviations as in previous figures; also, 1, 2, 3, 4, 5, cusps of the lower molars; *m. p.*, median plane; *, broken edge.

portion of the lower jaw, and the apelike canine tooth, rightfully belong to the portions of the brain case recovered; while the main discussion relates to the reproduction, or restoration of this skull.

The facts of the discovery are these: Several years ago Charles Dawson, F.S., F.G.S., noticed some peculiar dark flints that had been used in the repair of a road near Piltdown Common that were not usual in that district, and on inquiry learned they came from a gravel bed on a neighboring farm. On a subsequent visit to this pit he secured a small portion of an unusually thick human parietal bone, and later found a larger piece belonging to the frontal region of what was assumed to be the same skull. The interest aroused by these finds led to a careful search of the surrounding soil, and of the spoil heaps from the pit, with the result that several other portions of a skull were found, as well as the right half of a human mandible and a large canine tooth; which portions have all been assembled in a restoration of the skull of what, if the asserted facts are substantiated, must have been a human being who existed in the Paleolithic Age, at "the dawn of the world," as it has been said, and at a period far earlier than any other known indications of human life.

The facts, the evidence and the arguments concerning the various features of the Piltdown specimen, which has by some scientists been declared to be a new genus of the family Hominidæ, and which has been named *Eoanthropus dawsoni*, have been collected impartially by Dr. William King Gregory, the well known paleontologist, and published in the *American Museum Journal*, to which we are indebted for the following summary and illustrations.

GEOLOGICAL AGE OF THE PILTDOWN MAN.

The question of the geological age of these now celebrated specimens is naturally of first importance. It has been suspected by some that geologically they are not old at all; that they may even represent a deliberate hoax, a negro or Australian skull and a broken ape-jaw, artificially fossilized and "planted" in the

Fig. 3.—The Piltdown lower jaw.

(*B*) from a cast in the Williams Collection, compared with the jaws of a female orang-utan (*A*) and of a modern man (negro) (*C*). External views, three fourths of the natural size. Abbreviations: *alv*, m_3, socket for third lower molar; *a. r.*, ascending ramus; *c*, canine; *c. i.*, central incisor; *con.*, condyle; *l. i.*, lateral incisor; m_1, m_2, m_3, first, second, third lower molars; p_1, p_2, first and second premolars (equivalent to the third and fourth premolars of lower mammals).

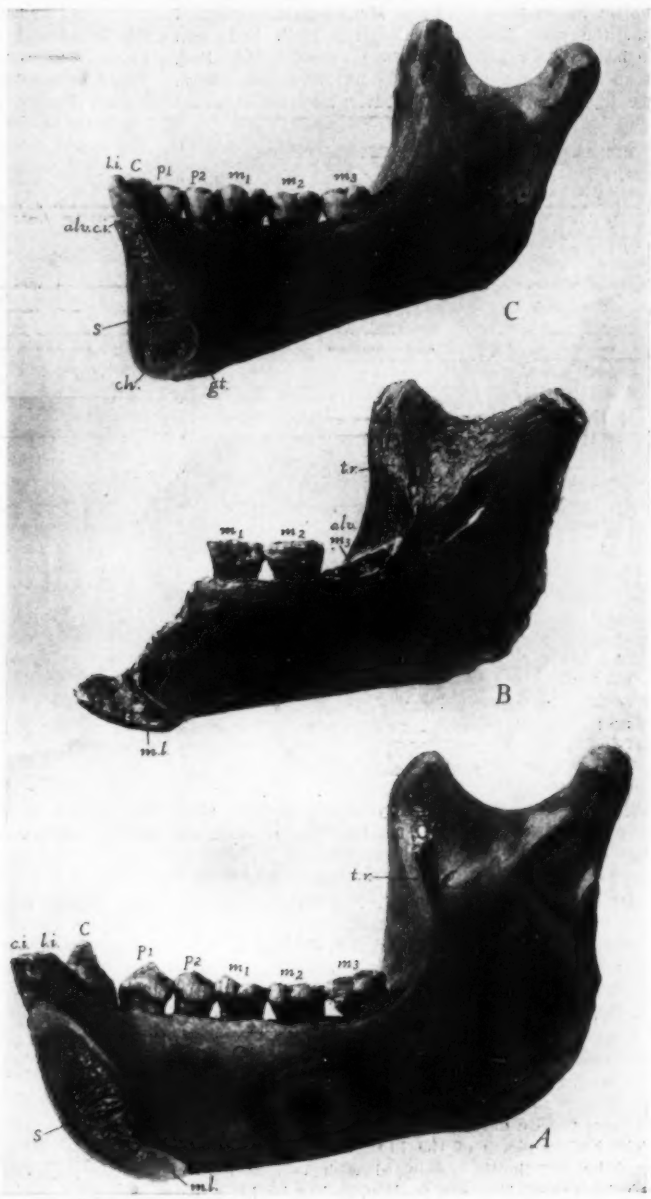


Fig. 4.—Lower jaw bones of the Piltdown man, of a female orang-utan and of a modern negro, viewed from the inner side.

Abbreviations as in Fig. 3; also, *alv. c. i.*, alveolus for central incisor; *ch.*, bony chin; *g. t.*, genial tubercle; *m. l.*, mental ledge; *t. r.*, ridge in area of temporal muscle; *s*, section through symphysis.

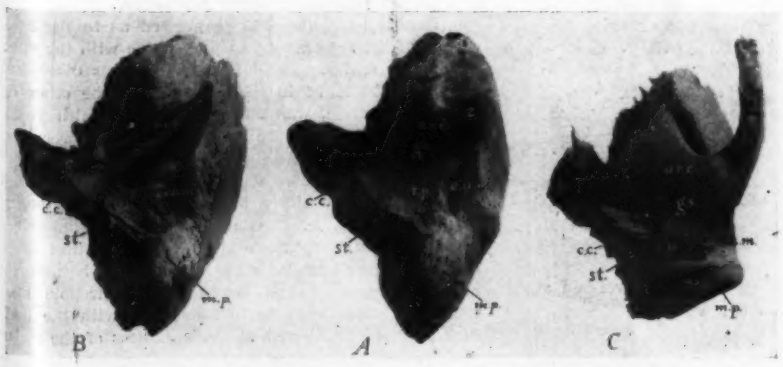


Fig. 7.—Temporal bones of the Piltdown man (A), of a negro (B), and of a female orang-utan (C). Two thirds natural size.

ar. c., articular eminence (for lower jaw); *c. c*, carotid canal; *c. a. m.*, opening leading to middle ear; *g. a.*, glenoid socket (for lower jaw); *pet.*, bone surrounding internal ear; *st.*, pit for styloid process; *t. p.*, tympanic plate; *z*, root of zygomatic arch.

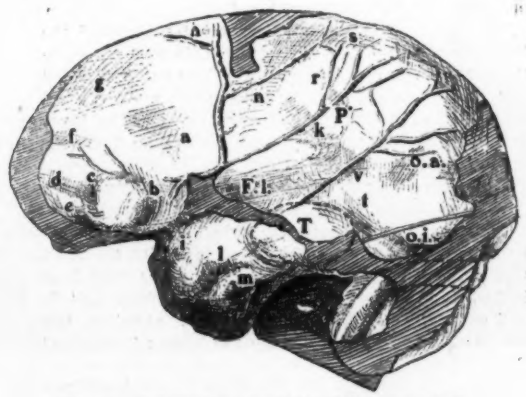


Fig. 8.—Internal cast of the Piltdown skull.

The fully shaded parts are represented in the original, the rest is restored. After Elliot Smith. The branching system represents the grooves for the meningeal arteries which are on the inner surface of the brain-case.

gravel-bed, to fool the scientists. Against this suggestion tell the whole circumstances of the discovery as above related. None of the experts who have scrutinized the specimens and the gravel-pit and its surroundings has doubted the genuineness of the discovery. All agree that the Dawn Man dates at the very latest from the Old Stone Age, and for the following reasons:

1. The dark stratum which yielded the human remains also contained a number of mammalian fossils, representing a primitive elephant (*Stegodon*), a mastodon (*Mastodon arvernensis*), a rhinoceros, a hippopotamus, a horse and a beaver. The mastodon and the stegodon belonged to species which were characteristic of the Pliocene Epoch, and on that account Prof. Keith at first regarded the human remains as equally old; but Dr. Smith Woodward and Mr. Dawson maintained that the mastodon and rhinoceros teeth had been washed into the gravel bed from an older formation, because they had been rolled and were water-worn. The hippopotamus and the beaver may be of either Upper Pliocene or Pleistocene Age. A fragmentary fossil antler of a red deer was found near by, but its association with the other remains is doubted.

2. "Eoliths," or irregularly fractured flints, were also found in and around the gravel-pit.

3. One flint implement of Old Stone Age type was discovered *in situ* in the bed which lies immediately above the Dawn Man stratum. (See also Fig. 11.)

In brief, the discoverers of the Dawn Man finally refer his remains to the Palæolithic (Old Stone) Age,[1] but the more precise date is not settled.

The broken pieces of the Piltdown skull were compared by Dr. Smith Woodward with various human types both prehistoric and modern, and under his direction the pieces were assembled as far as possible in their natural positions and the missing parts were hypothetically restored in clay. As shown in this reconstruction (Fig. 2) these missing parts (indicated by the white areas) include the front part of the lower jaw, the lower incisors, canines and premolars, all the upper teeth and the face. Since that time the nasal bones and one canine tooth have been found.

The most extraordinary, unexpected feature of the Piltdown man, as thus reconstructed, is that an essentially human brain case, with a well-rounded forehead and with thoroughly human temporal and occipital regions, is combined with an essentially apelike lower jaw, with apelike teeth and with an apelike face (the latter hypothetical).

DID THE APELIKE JAW BELONG WITH THE HUMAN BRAIN-CASE?

Doubts and criticisms were raised at once. Doubt as to the association of the lower jaw with the skull was expressed by several authorities (Sir Ray Lankester, Prof. Waterson and Prof. Schwalbe) and is still entertained by many conservative anatomists. Did this ape jaw really belong with the human brain-case? Could an ape jaw articulate with a human jaw-socket?

Briefly summarized the principal items of evidence bearing on this question are as follows:

1. The jaw was found in the same stratum which had yielded the skull, and within a yard of the exact spot where a piece of the occipital bone was found. Subsequently the nasal bones and a canine tooth were found in the same place.

2. The jaw and skull are fossilized in the same manner and degree.

3. They were found in an ancient gravel-bed containing the débris of older deposits. "As the skull and lower jaw are very little water-worn, they would not have occurred in close association if they had been transported far from the spot at which they were originally entombed" (Smith Woodward).

4. The suggestion that while the brain-case was human, the lower jaw belonged to another creature, an ape, is not in harmony with what is already known of the fauna and climate of Europe during Pleistocene times. Thousands of mammalian remains of Pleistocene Age have been discovered in the glacial and interglacial deposits of England and the Continent, but in this highly varied fauna the anthropoid apes have always been conspicuously absent, and there is no reliable evidence that any of the race ever lived in England during the Pleistocene Epoch.

5. Fossil remains of anthropoids of any age have hitherto been exceedingly rare, and the chances that a jaw of a hitherto unknown type of anthropoid ape should be washed into the same gravel-bed with a human skull of conformable size, and that both should become mineralized in the same manner and degree, may be regarded as extremely small.

6. More direct evidence that the lower jaw, in spite of its apelike features, is really that of a human being is furnished by the measurements given by Dr. Smith Woodward (*op. cit.*, p. 130). These measurements are on the whole nearer to those obtained from early human jaws than to those of full-grown apes.

7. The lower molars approach those of apes in their relative narrowness and in the large size of the third lower molar (as indicated by its alveolus), but in their flattened worn surfaces with very thick enamel they recall human rather than simian teeth.

8. The condyles, or articular surfaces, of the Piltdown jaw as compared with those of the great apes were more slender, less expanded transversely, and supported by more slender pillars of bone. In this feature the Piltdown jaw is more like the average human type, and this fact tends to remove the supposed difficulty in fitting this, in many ways, apelike jaw on to a human glenoid, or upper jaw socket.

9. Doubts have also been expressed as to the association of the remarkably apelike canine with the other Piltdown remains. The canine, which was discovered by Father Teilhard in the place where the other remains came from, was identified by Dr. Smith Woodward as belonging in the right side of the lower jaw; but as shown in Fig. 6, by comparison with the upper and lower canines of a female orang, its resemblances are on the whole closer to the left upper canine, as observed by Mr. A. E. Anderson. If it be an upper canine its wearing surface is such that the first lower bicuspid which occluded with it must have been elongate and prominent and much more anthropoid than human in shape. Taken in connection with the total lack of a chin, and with the straightness of the molar tooth rows, this indicates that the lower part of the face and the dentition were even more apelike than in Dr. Smith Woodward's reconstruction. If the canine be an upper one, this would tend to confirm the association of the jaw with the skull, in the opinion of American Museum collectors.

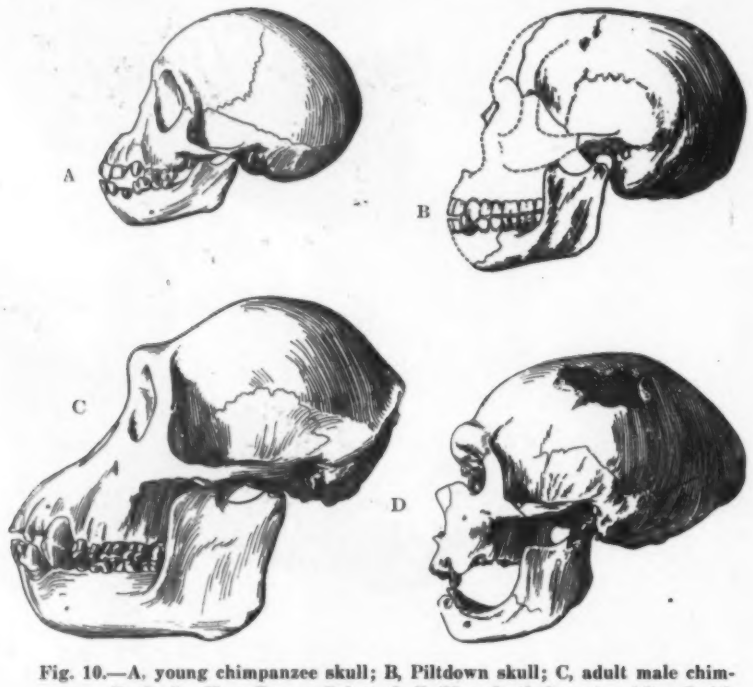


Fig. 10.—A, young chimpanzee skull; B, Piltdown skull; C, adult male chimpanzee; D, the La-Chapelle-aux-Saints skull (Neanderthal race). After Smith Woodward.

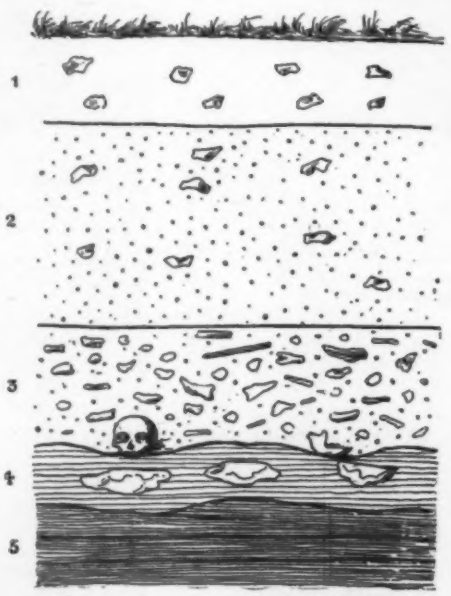


Fig. 11.—Diagram of section of gravel-bed at Piltdown. After Dawson.

1. Surface soil, with flints; thickness, 1 foot. 2. Pale-yellow sandy loam with gravel and flints. One Palæolithic worked flint was found in the middle of this bed; thickness, 2 feet 6 inches. 3. Dark-brown gravel, with flints, Pliocene rolled fossils and *Eoanthropus* remains, beaver tooth, "coliths" and one worked flint; 18 inches. 4. Pale yellow clay and sand; 8 inches. 5. Undisturbed strata of Wealden age.

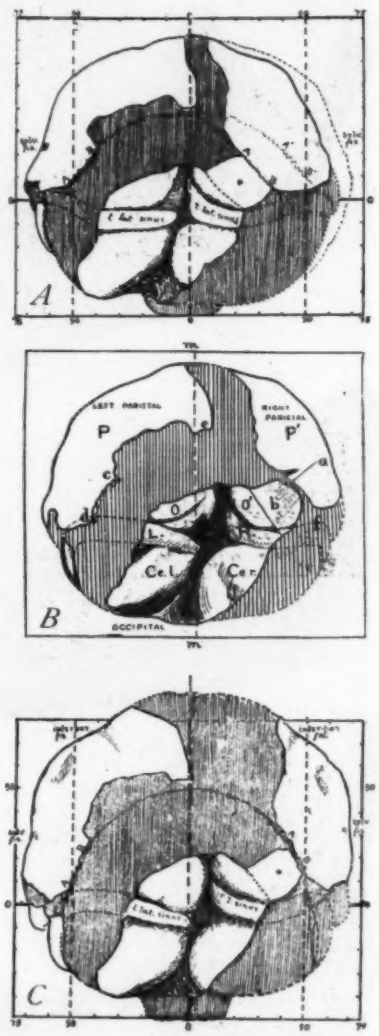


Fig. 9.—Projections of the brain-case as seen from the rear, as reconstructed by Professors Smith Woodward (A), Elliot Smith (B), and Keith (C).

[1] Supplementary Note on the Discovery of a Palæolithic Human Skull and Mandible at Piltdown (Sussex). Proc. Geol. Soc., London, vol. lxx, 1914, pp. 82-93.

DID THE PILTDOWN MAN HAVE A VERY LARGE BRAIN CASE?

We come now to the most controversial part of the whole subject. Did the Piltdown man have a small brain case as in Dr. Smith Woodward's reconstruction (Fig. 9A), or a very large one as in Prof. Keith's reconstruction (Fig. 9C), or one of intermediate type as in the drawing published by Prof. Elliot Smith (Fig. 9B)? Unfortunately several pieces of critical importance are missing from the middle of the skull-top and this has made possible the markedly different results of Smith Woodward and Keith. For if the remaining pieces of the skull-top are placed close together as by Dr. Woodward, the brain will be a very small one, estimated at 1,070 cubic centimeters capacity, while if these same pieces be tilted upward and moved farther apart as by Prof. Keith, the brain capacity will be as large as in many modern men, namely 1,500 cubic centimeters. The subject is an exceedingly difficult one, as the writer has learned to his cost, after long efforts to assemble the casts of the separate pieces in their natural positions. It may be briefly stated that the writer inclines to the reconstruction offered by Dr. Elliot Smith (Fig. 9B), which avoids the extreme asymmetry of the opposite halves of the brain case noticeable in Dr. Woodward's reconstruction, and gives more space at the top for the ends of the meningeal vessels. Dr. Elliot Smith has also discovered certain marks on the inner surface of the frontal bone which appear to settle the vexed question of the location of the median plane.

THE PILTDOWN MAN AS ONE OF THE "MISSING LINKS."

As stated above, the temporal bone and its mastoid process, the back of the head and the whole brain case, as well as the brain cast, are human in character, although of low type, while the lower jaw and dentition are prevailingly simian. And while this regional distribution of human and simian characters was unexpected and in a way unprecedented, it means, as Prof. Elliot Smith has noted, that the erect poise of the body, the freeing of the hands from locomotive functions, and the human development of the brain were associated in the Piltdown man with a more conservative or simian structure of the dentition and jaw.

Whether or not the Piltdown man could talk is an open question. Dr. James Robinson has pointed out that in modern man the genioglossus muscle, the principal muscle of the tongue, is differentiated into many more or less separate strands, each with its own nerve supply and that this arrangement permits the extremely rapid and delicately co-ordinated movements of the tongue in speaking, whereas in the apes this muscle is much smaller and less differentiated. In modern man the muscle is attached to two little tubercles on the inner side of the chin, known as the genial tubercles (Fig. 4, *g. t.*). In the Piltdown man, as in the apes, these tubercles are absent and the tongue rests below upon a shelf of bone. Nevertheless it may not therefore be assumed that the Piltdown man was entirely speechless. The brain cast shows in the temporal region (Fig. 8) an elliptical swelling *T* which foreshadows a certain greatly expanded center in the modern brain, a center "which recent clinical research leads us to associate with the power of spontaneous elaboration of speech and the ability to recall names" (Elliot Smith).

EVOLUTIONARY SIGNIFICANCE OF THE PILTDOWN RACE.

Assuming that the jaw really belonged with the brain case, Dr. Woodward very properly erected a new genus and species *Eoanthropus dawsoni* for the reception of this strange creature. He pointed out also that the rounded forehead with little or no brow ridges is characteristic of young apes (Fig. 10A), while the flattened forehead with projecting brow ridges is characteristic of adult apes (Fig. 10C), and also of the prehistoric Neanderthal race of man (Fig. 10D); he therefore suggests that the still undiscovered mid-Tertiary apes which gave rise on the one hand to the various species of mankind and on the other to the existing anthropoids probably had rounded foreheads and a relatively short face.

Prof. Keith's widely published but very questionable reconstruction showing the Piltdown man with a highly modernized brain-case has given opportunity to that part of the public which dislikes the idea of man's evolution from lower animals, to express the opinion that "the Darwinian theory is exploded." By palæontologists and comparative anatomists, however, the evidence for man's cousinship with the anthropoid apes is regarded as no longer an hypothesis.

The proof of the ascent of man from certain still undiscovered mid-Tertiary primitive apes does not rest largely upon the scant fossil remains of extinct races of men and of apes. It does rest upon the convergence of many lines of evidence offered by the embryology, anatomy and fossil history of numerous races of animals. To mention only a single line of evidence, the adult anatomy of man and of the anthropoid apes is extraordinarily similar not only in general plan throughout, but in thousands of minute details in every part of the body. By a detailed comparison of the skulls of man, anthropoid apes, and Old World monkeys and other mammals one sees directly that the human skull is merely a special modification of the primitive anthropoid type, with the brain case larger, the face shorter, the dentition weaker; but everywhere the fundamental architecture is the same. For example, consider the region of the under side of the temporal bone in man and in the anthropoids (Fig. 7); here are precisely homologous parts throughout, the same processes and ridges, the same canal for the internal carotid artery, the same styloid pit for the attachment of the hyoid bone and so forth. And so it is everywhere, throughout the skull and the entire skeleton, throughout the marvelously intricate architecture of the brain, spinal cord, and musculature, in all the vascular, respiratory, digestive and reproductive organs; so that no matter how long one continues the comparison, new similiarities are constantly being revealed.

Palæontologists and comparative anatomists likewise recognize and value the differences between men and apes. They realize that even the lowest existing races of mankind are extremely superior to apes in mentality, in power of speech and in ability to use the hand as an organ of the will and intelligence. But they also believe that all these higher faculties, marvelous as they are, find their beginnings in the psychic and physical life of the apes, that the key to the mental and structural adaptations of mankind is to be found in the Primates alone among mammals.

Such being the general viewpoint of palæontologists and comparative anatomists, it need hardly be said that, to them, the Piltdown man, far from disproving the "Darwinian theory," is indeed a sort of "man in the making." He is one of the innumerable experiments made in nature's vast laboratory, an early branch of the prehuman stock which had achieved a low human stage of brain and brain-case, but which in face and dentition still bore unmistakable traces of derivation from large brained, primitive anthropoid apes.

Testing Polarity of Field Coils*

By F. A. Annett

After the field coils have been taken out of a motor or generator for repairs or rewinding, unless they were carefully marked, the electrician is confronted with the problem of getting them back in the machine with the proper polarity. In many cases, the method of procedure is to first place the coils in the machine and connect them up temporarily; then test the pole-pieces for the proper polarity, but this is accompanied usually with considerable labor, for if the electrician is unfortunate enough to have a number of the coils of the wrong polarity, considerable unnecessary labor is involved in removing and reversing them.

A better method is to test the coils before they are placed in the machine, which may be done as follows: First, place the coils and connect them as in Fig. 1, then after closing the switch to the line, test the coils with a compass for the proper polarity. The compass should point alternately north and south in adjacent coils, as indicated in Fig. 1. If a condition is found like that shown in Fig. 2, where three adjacent coils are of the same polarity—that is, *A*, *B*, and *C* are north poles, change coil *B* end for end or interchange the connections on it. This method means that coil *B* will have to be revolved through one half revolution to bring the coil terminals in the proper position to make the connections.

Again, consider a condition as that in Fig. 3, where coils *A* and *B*, *C*, and *D* are alternate north and south poles, but adjacent coils *A* and *D* are north poles and coils *B* and *C* are south poles. To remedy this condition, it will be necessary to change coils *C* and *D* end for end or interchange the connections on them to bring the four poles into the proper polarity. After the desired condition has been obtained, the coil may be placed on the polepieces just as they are located, as indicated in Figs. 1 and 4. After the coils have been located on the polepieces, they may against be tested with a compass to see if the work has been done properly.

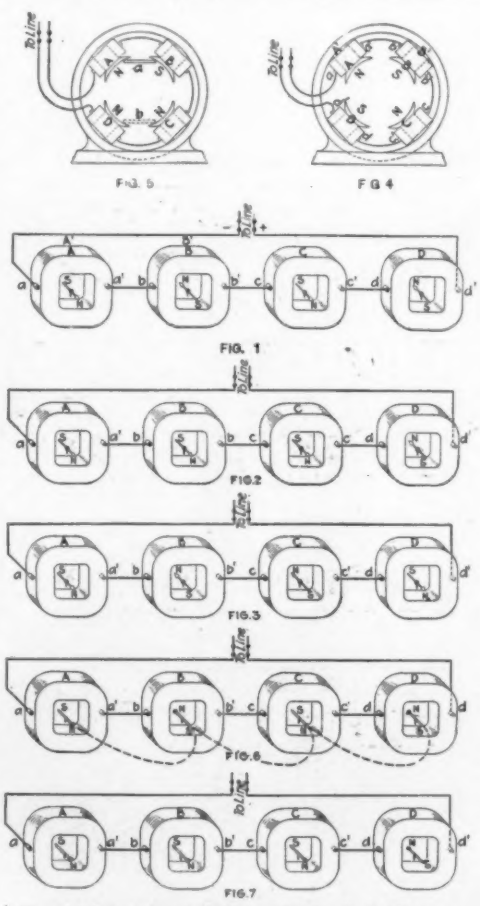
When testing for polarity with a compass, care should be taken to always so hold it that the needle is free to move, for if the compass is shifted from one polepiece of opposite polarity, if the needle is not free to move, the polarity of the needle will be reversed and will indicate that the fields are of the same polarity; this might lead one into considerable trouble. A good plan is to make the test two or three times so that the chances of making a mistake will be reduced to a minimum.

Another convenient way to test the polepieces for the proper polarity is with a piece of iron, long enough to reach from one polepiece to another and placed as shown at *a* in Fig. 5. When the poles are alternately north and south, as at *a*, the iron will be strongly attracted; if both polepieces are of the same polarity, as at *b*, the attraction for the piece of iron will be very weak, and it will be repelled when brought close to the polepieces. Care should be taken not to mistake the weak attraction which two like poles have for a piece of iron when brought in contact with them, for the strong pull two unlike poles will exert on the same piece of iron.

A good plan is to try the pull between any two poles, and if it is not very strong, interchange the connections on one coil. If the pull is increased the polarity is correct, and if decreased, the polarity is wrong and the coil leads that were interchanged should be changed back.

When a compass is not at hand for making the test as described in Fig. 1, a wire nail may be used for the purpose as indicated in Fig. 6. After the coils have been energized, if the nail is placed in one of them it will be magnetized and retain enough of the magnetism to act as a compass needle.

Care should be taken in using it as the magnetism will be easily reversed in it. Furthermore, it should be moved from one coil to another in the curved line as indicated by the dotted lines in Fig. 6. If the coils are of the proper polarity, the nail will point in the opposite direction in adjacent coils. If two adjacent poles are of the same polarity, the nail will point in the same direction as shown in Fig. 7, which can be corrected as in Fig. 2.

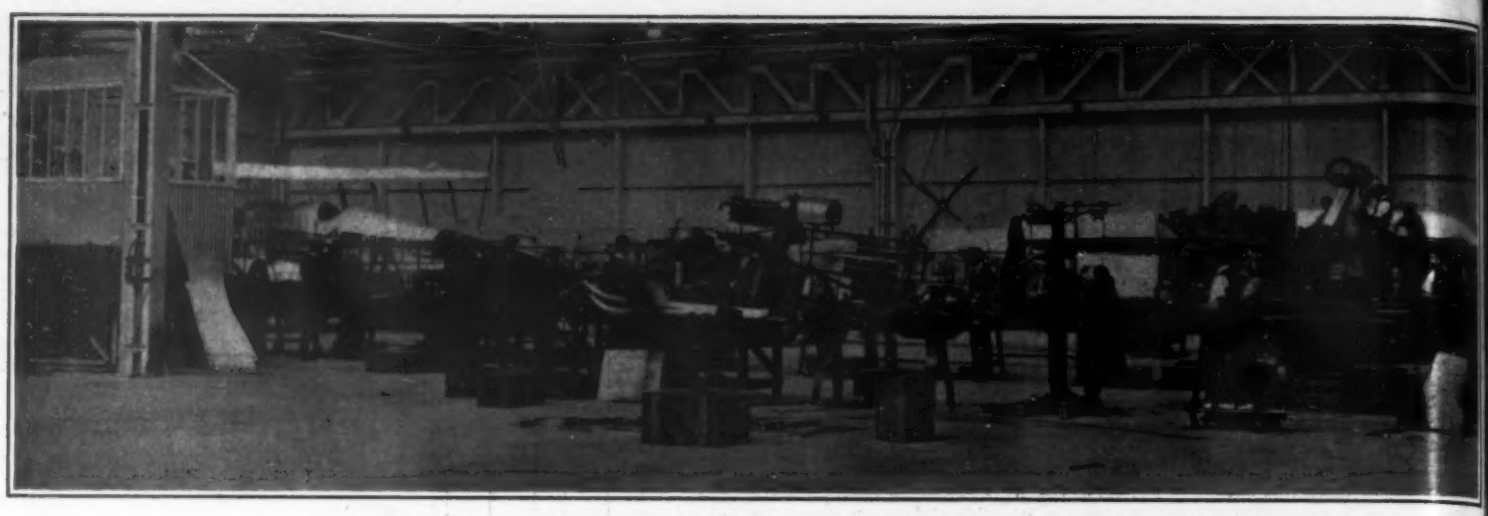


How to determine polarity of field coils by the use of a compass or a nail.

* Reproduced from *Power*.

Scientific Study of Aeroplanes

Few people outside those directly interested are aware of the degree of scientific study and experiment that is being devoted to flying, and that there are already in existence a number of great aerodynamical laboratories which have done much valuable work. The oldest of these is at Koutchino, Russia, under the direction of Dr. Riabonchinsky. At Paris is the laboratory of M. Eiffel, where this famous engineer has for a number of years carried out most valuable researches. Paris possesses another laboratory, planned on an ambitious scale, founded at St. Cyr through the generosity of M. Deutsch and controlled by the University of Paris. At Rome there exists a well-equipped laboratory belonging to the Italian Aviation Corps, and finally there is the admirable aeronautical section of the National Physical Laboratory at Teddington.



One of the shops of the Royal Aircraft Factory at South Farnborough, England.

A Visit to the Royal Aircraft Factory

Where the British Government Develops its Air Scouts

By Brigadier-General F. A. Stone, Late R.A.

By permission of the War Office and by the courtesy of the superintendent, Mr. Mervyn O'Gorman, I was enabled recently to spend a most interesting and profitable day at the Royal Aircraft Factory, South Farnborough.

The duty of the factory is not only to design and construct experimental aircraft and the attendant instruments, engines and appurtenances for the army and navy, but to make a certain limited number of each type with a view to developing its designs till they are suitable for manufacture by private aeronautical constructing firms.

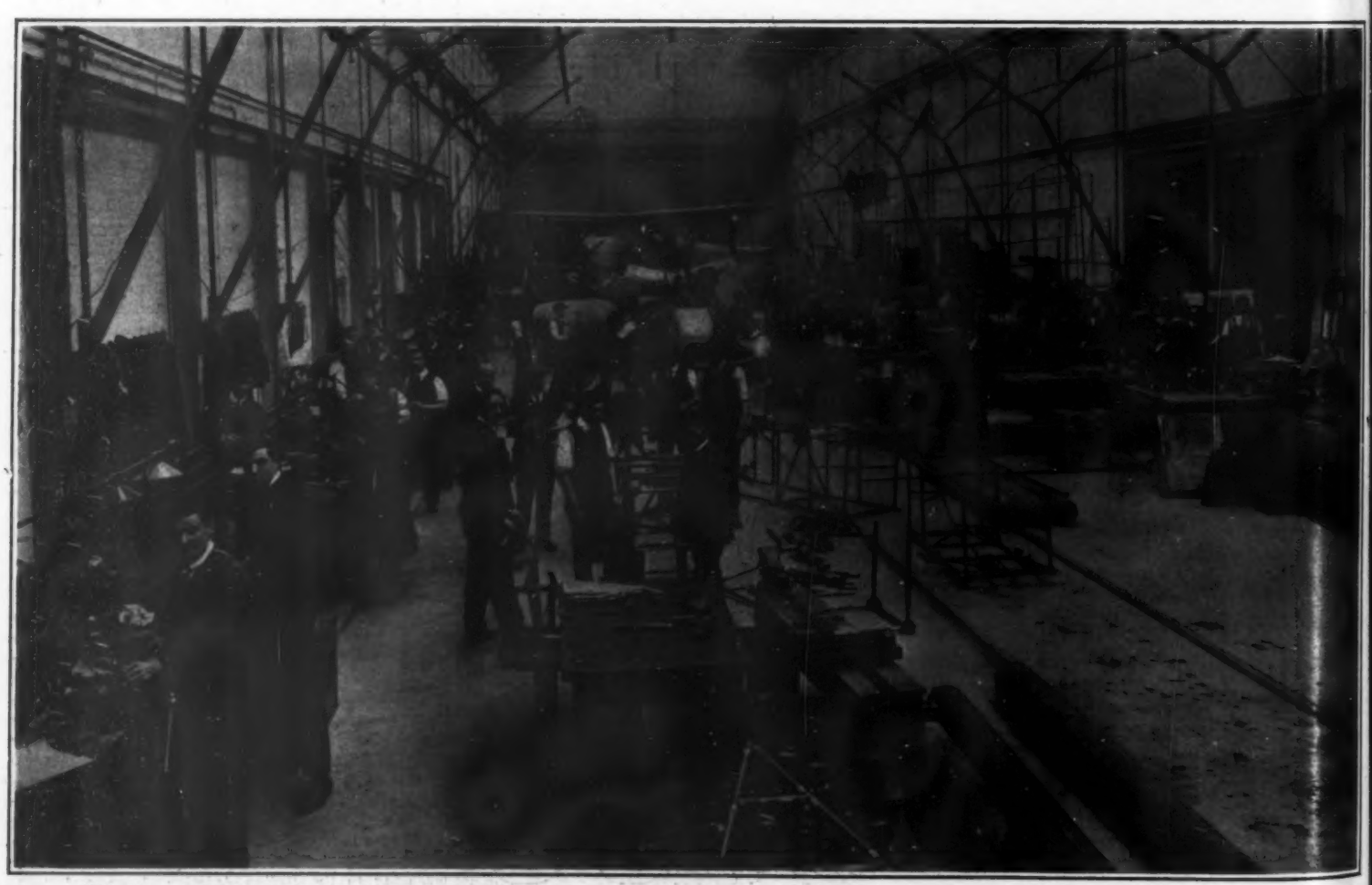
Aircraft of original design, purchased by the government from outside sources, are submitted to the same severe tests by the inspection branch as the government machines, before being passed into the service, for use by the officers of the Royal Flying Corps; if they do not satisfy the test for the minimum factor of safety, they are not passed into the service; it may be observed that the Aircraft factory machines have a high safety factor.

One thing is quite clear, viz., that the officers of the Royal Flying Corps have nothing to fear in regard to structural weakness in any machine passed out of the Royal Aircraft Factory, and may indeed feel additional confidence in those machines which have been constructed to the Aircraft Factory specification.

There are three standard designs now being manufactured:

1. The one-seater scout (S.E.) for fast work of a special nature, in which speed is the predominating factor, and this type is only used by the more experienced pilots. Of course the principal difficulty with such machines is to learn to fly them slowly for landing. The tractor screw is in front.

2. The two-seater reconnaissance machine (R.E.) (formerly called B.E.) for the normal work of reconnoitering. This machine has the tractor screw in front also; the engine is in front; the observer is seated in front of the pilot, and the planes are slightly staggered. The aeroplane design gives a variation in speed of nearly 40 miles an hour between maximum and minimum. A Renault engine of 70 horse-power is used, but the original design was evolved on a Wolseley engine of the same power with excellent results. There are a number of vertical fins on the upper surface of the top plane of the latest machine, designed to give automatic lateral stability; these fins are a special feature of the machine, their area and design have been calculated with mathematical precision, and may be said to achieve the same end, which was more roughly aimed at in the old cellular type of Voisin machine. The landing chassis is also a special feature, the two skids being rendered rigid laterally by an ingenious



Main shop of the Royal Aircraft Factory at South Farnborough, England, where the British Government is developing and building flying machines for military purposes.

...l original system of stays, without any cross tran... which would interfere with the free running of ...e skids on rough ground or crops.

This machine is very fast and safe. Mr. Henry Far...an was much astonished at seeing a comparative beginner flying on one of these machines in a 50 miles per hour wind, and he asked whether the pilot was an old hand, and could scarcely credit the fact that this type of machine was so stable that it was perfectly safe for a comparative tyro under conditions which would prevent such a pilot from attempting a flight on almost any other type of machine. In this connection it is also necessary to bear in mind the immense advantage given by the wide range of speed variability.

New reconnoitering biplane (R. E. class) built at the Royal Aircraft Factory.

3. The latest type is the fighting machine, which carries an automatic gun in front. In this case it is necessary to have the propeller in the rear instead of a tractor screw in front: the gunner is seated immediately behind the gun, and in front of the pilot.

Both this type and No. 2 can carry armor, and are also designed so that every strut and stay is duplicated, in such a way that the shattering or severing of any wire by a rifle bullet or the perforation of a spar will have no effect on the efficiency of the structure; I do not mean that *doubled* struts or wires are used, but that the design is so worked out that every strain is borne by more than one *system* of support, and that no individual stay is in itself indispensable.

Silencers cannot be fitted to rotary engines, such as the Gnôme, and that this is a drawback cannot be denied; but the other good qualities of the Gnôme engine keep it still to the front, though there is another rather serious drawback to the use of all but the very latest type for military purposes or for long-distance flying, and that is its extravagant consumption of lubricating oil. The new monosoupape type is claimed to have entirely overcome this.

Self-starters are in the design of all the recent Royal Aircraft machines, but when it comes to turning out the complete machine it has generally been found in the past that the self-starter has to give way to something else which, for the present at any rate, is considered a more useful way of employing the weight.

With regard to future developments, the cheery optimism of Mr. O'Gorman, based as it is on exact scientific knowledge and training, and unique experience of up-to-date work and practical achievement, fills one with confidence, not only as regards the extended scope of aviation for military purposes, but also as regards its commercial value. Mr. O'Gorman contemplates, as a reliable ideal, the transport of field guns by weight-carrying aeroplanes, with a view to opening fire on an enemy with artillery under circumstances which would have precluded the aid of the guns under ordinary conditions of transport. He is also sanguine as to the early employment of aeroplanes by the post office, and for commercial purposes. As regards the latter, it is a little difficult for soldiers, who are rather out of touch with the hustle of commercial life, to realize the importance of saving 24 hours in the delivery of certain commodities. Women's fashions alone offer a field for this class of enterprise. It is only necessary to recall the tea clippers in the middle of the last century to understand what lengths those engaged in certain branches of the carrying trade will go to, in order to deliver goods earlier than their rivals. These ships were as well found in every respect which mattered for speed as any first-rate racing yacht; their sails were frequently of silk, and no expense was spared to secure the highest possible rate of speed and the quickest run, to land the first tea crop of the season.

The Double Cocoanut Palm

THE accompanying illustrations show the male and female trees of the double cocoanut palm growing in the botanical garden, Georgetown, British Guiana. This is not the true cocoanut (*Cocos nucifera*), but an entirely different species (*Lodoicea sechellarum*), which is native to several small islands of the Seychelles group lying just east of Madagascar in the Indian Ocean. The young palm trees shown here were raised from seed brought from the Seychelles, and they are now about twenty-five years old and are just beginning to bear fruit.

This palm, which the English people call maldive nut tree and the Portuguese coco de mer, produces the largest known fruit in the world. The fruit was known many years before the tree on which it grows. Portuguese sailors first found these immense woody nuts floating on the water in the neighborhood of the island on which the palm grows. For many years the sailors, as well as botanists, believed that these nuts were the fruit of enormous sea weeds growing in the deep water of the Indian Ocean, but in 1789 it was discovered that they were the product of a magnificent palm tree growing only on the Islands of Praslin and Curiense. The empty shells, or occasionally the unsprouted fruit of this palm, are washed down the streams into the ocean, and a few nuts were fished up by the sailors and brought to Europe as a great curiosity in the sixteenth century.

The double cocoanut palm does not produce flowers until it is about twenty years old, when the male tree puts forth catkins which are about three feet long and three inches in diameter; the female tree produces a zigzag stalk on which the flowers are arranged alternately, and on which a few, or sometimes as many as eleven nuts are borne. These nuts are brownish-black

Coco de Mer, or double cocoanut (male).

Double cocoanut (female).

in color, often over a foot long, nearly as thick, and deeply bifurcated. The shell is very hard, strong, and resists decay to a remarkable degree. The inner portion is fleshy and consists chiefly of albuminous matter which represents the accumulation of years, for the seed requires from seven to ten years to mature. The fruit is full grown at the end of four years, when it is soft and filled with semi-transparent jelly-like substance. The fully matured nuts weigh about forty pounds.

The albuminous substance in the interior of these largs nuts was at one time believed to contain medicinal properties, and fabulous prices were often paid by rich Indian princes for a single nut. The active principle was employed chiefly in counteracting poison, but it has long since lost much of its repute, except with a few of the poorer classes of the Seychelles Islands. It is used at present in India, where it is still looked upon as a curative and preventative for a good many dreaded diseases. At one time a single nut cost as much as $500, but at present they can be bought for less than a dollar.

The double cocoanut palm does not attain maturity before it is one hundred years old. The male trees produce a cylindrical stem about one foot in diameter and upward to twenty-five feet from the base to the crown. The crown is composed of a dense mass of large fan-shaped leaves twelve to fifteen feet long. The female trees are always smaller. The wood is exceedingly hard, heavy, strong, and almost indestructible. It is used largely in the construction of houses and for other purposes requiring a durable wood. Their chief use is for roofing and siding of houses, but large quantities are employed also by native women in making beautiful wicker work, which is embroidered with silk from Madagascar. The use of the wood and of the top has been so great in recent years that the English government has now taken steps to preserve the remaining trees in the few small localities where they grow naturally. The leaves are almost as valuable as the wood to the natives, who make use of them for a great variety of purposes.

Feeding the German People in Time of War

Discussed by a German Authority Before Hostilities Were Declared

How long could the German Empire feed its population from domestic products alone in case her enemies could so forge that "iron ring" of which we have been hearing so much as to cut off all importation of provision for man and beast? For a number of years the subject has been much discussed, not only by Germans, but by French and English writers as well. The events of the past few weeks have suddenly made it of practical and portentous interest. Writing last March in the *Preussische Jahrbücher*, Count von Moltke took a distinctly optimistic attitude. While denying the probability that her ports could be completely blockaded, he declared Germany could long support her people by the products of her own soil.

In the July number of the same magazine a very opposite view is taken by one of the most prominent publicists in Germany, Dr. Carl Ballod, *Ordentliche Honorarprofessor* of the University of Berlin. Fifteen years ago, declares Dr. Ballod, there might have been reasonable hope of success by taking prompt and energetic measures, such as the deflecting of grain from the hands of the distiller and the brewer to those of the baker. To-day, he declares emphatically, this is no longer possible. It is true that the imports of bread grain have fallen off of late years, and this year Germany has even been exporting a large number of tons of rye instead of importing it as in the 90's. But Dr. Ballod properly lays stress upon the fact that the amount of bread grain imported or exported is only one factor in the problem, and that no just conception of the situation can be arrived at without considering it in connection with the total consumption of all grain, fodder, oleaginous foodstuffs, etc.

"The importations of bread grain are diminished," he states, "but the total importations of grain and all foodstuffs have tremendously increased. In 1911-1913 we imported about 10,000,000 tons of grain and fodder, and also at least 5,000,000 tons of *grain equivalent* in the shape of 900,000,000 marks' worth ($225,000,000) of cattle, meat, tallow, herring, eggs, butter, and cheese. Even if we accept the German harvest statistics as absolutely correct—26,000,000 tons net for 1911-1913—it will be seen that a full third of the grain needed for food was imported. . . . It is therefore a fearful self-deception to estimate that the German nation can amply supply itself with the bread grain needed for eleven months in the year. Amply! Yes, so long as 60 per cent of the fodder required by the necessary cattle can be imported! The cutting off of fodder importation means a decrease in the milk yield to three fourths as much at the most, while in swine-breeding the consequences would be nothing short of a catastrophe; two thirds of the pigs and young hogs could not be fed, but would have to be slaughtered as soon as possible.

"Hence, cutting off importations of food means a decrease in the consumption of animal food by one half, and consequently a crying need of increase in bread consumption."

Dr. Ballod here interpolates a scathing criticism of the method of obtaining statistics of grain yield in Germany, which he considered far less accurate than that of England. He concludes that the crops statistics are overestimated by 15 per cent on an average for the whole empire. This would reduce the yield for 1911-1913 from 28,000,000 tons to only 23.8 million tons gross, or 21.7 million tons net. He acknowledges, however, that the enormous yield of potatoes, over 40,000,000 tons net, in the last three years is an important factor in the feeding of the population, but says the nutritive value of the potato should not be exaggerated, as has been done by Behrend. His remarks on this point are of general interest. He says:

"The potato is a *one-sided* food; it contains, according to Kellner's tables (the only ones now used), 15 to 19 per cent of starch, but only 0.2 per cent of albumen and 0.1 per cent of fat. Hence, the ratio of starch, albumen, and fat is as 170:2:1, whereas the human requirement of these food elements is as 10:2:1, and the requirement of animals is not very different. Advantageous as is the process of drying potatoes, by way of preserving large quantities which would otherwise rot, it does not solve the problem of the nutrition of man and beast, since for rational nutrition additions of albuminous and of fatty foods are unconditionally required. That potatoes can be used to replace part of a horse's rations of oats, when the animal is not working, is true, but every farmer reduces the oats ration for idle horses in any event. Hence, if by the general introduction of potato drying 10 per cent of the crop now lost could be saved, i. e., about 4,000,000 to 5,000,000 tons, this would be a great achievement; but we must not forget that this 4,000,000 to 5,000,000 tons of potatoes is the equivalent of only about 1,000,000 tons of wheat or energy-yielding fodder, while we import tenfold that amount. Indeed, it might even be maintained that the more potatoes were thus saved, the more need of importing foods containing albumen and fats, as otherwise the excess of potatoes would not be balanced.

"To be sure, we could raise in the interior greater amounts of albuminous and oleaginous crops—beans, vetches (wicken), flax, turnips, (rübsamen), but this could only be done by cutting down the area devoted to grain and potatoes, which would hardly be rational.

"Count Moltke dilates on the fact that great quantities of our own wheat and rye are, in times of peace, made to serve industrial ends by transformation into grain alcohol, starch, etc., and therefore withdrawn from consumption as food. It is worth while to inquire into the amount of these quantities. In 1909-1910 it amounted to 341,000 tons, and in 1911-1912 the amount had risen to 509,000 tons, but this was because of the failure of the potato crop."

Prof. Ballod then raises the question whether the total food value of the grain and potatoes usually distilled would be gained as an extra supply of nutrition in case breweries and distilleries were put out of commission. This portion of the article is of peculiar interest in view of the fact that recent dispatches stated that the German government had already diverted 40 per cent of distillers' supplies to nutritive purposes. Prof. Ballod reminds us that half of the nutritive value of the grain remains in the refuse or "slops" from the stills. Moreover, it is the most valuable half, since it contains almost the total content of albumen and fat—the very elements which would be most needed in case imports were checked.

Prof. Ballod continues: "It is still an open question whether an increase of food would not be necessary if the consumption of alcoholic liquors, etc., ceased. For, though alcohol be not a food, yet, according to the prevailing view to-day, its use lessens the amount of food required. It is even more problematic whether gain of nutriment would result from closing the breweries."

Another point raised by the author is that total abstinence forced on a people used to moderate indulgence in alcoholic drinks might cause widespread mental depression, and he remarks that "mental depression alone is capable of losing battles!" Furthermore, he says: "It is well known, for example, that certain polar explorers like Nansen, who boasted of having used no alcohol on polar expeditions, found that all the members of the party fell into a very gloomy frame of mind. On the other hand, in the German South Polar Expedition, the men's spirits were excellent, which is attributed to the fact that a moderate ration of alcohol was allowed."

Even more drastic is Prof. Ballod's criticism of Count von Moltke's comfortable, but, as it now appears, mistaken assumption that Germany's frontiers and ports of entry could never be completely blockaded, and that, even if they could, she possesses abundant means to feed the populace. He says emphatically:

"I am sorry to be obliged to contradict this optimistic view most decidedly. It is far more true that the provisioning of the population would be seriously endangered. In the first place, it is absurd to say that such a blockade could *never* be made complete. Does Count von Moltke believe that the Belgian, Dutch, Danish, and Swedish harbors would remain open in the worst case conceivable, that of the Triple Entente against the Triple Alliance? That England, after war had been declared, would permit her merchants and shipowners to shower food upon us *via* Holland? English writers hold other views. They say openly they could starve out Germany. Note also, that to cut off food from Germany, England would not even have to violate the neutrality of Belgium and Holland. Two thirds of the grain boats which go to their ports are English, a fact German writers do not seem to know. The English government need merely order English ships to remain in their harbors. . . . Moreover, Belgium must herself buy 2,500,000 tons of grain to supplement her own crop of 1,500,000 tons, while Holland buys 1,500,000 tons to supplement her own 1,000,000 tons. Hence, the neutrality of Belgium and Holland is worthless."

Dr. Ballod then gives a valuable summary of the crops and imports of grain of various countries even more interesting now than when written. Switzerland produces a quarter of a million tons and imports three quarters of a million tons, half of which is wheat. She draws from Mannheim, Genoa, and partly from Hungary. Austria-Hungary in ordinary years has no excess, and in bad years, such as 1900, must import three fourths to one million tons of wheat! Italy imports, of wheat alone, 1,250,000 to 1,500,000 tons, which is why English favor is a matter of such importance to her. Rumania? Yes, if we were sure of her . . . in good years she exports 2,000,000 tons, equal to one fourth to one fifth of the necessary German importation. But Rumania has become uncertain as regards us. Denmark? The *hostile* neutrality of Denmark is obvious. Sweden-Norway? Sweden imports one fourth of the bread grain she needs, and Norway three fourths of her needs. Both largely depend on Germany for rye. Of course, the neutral grain boats in Norwegian ports could be ordered to bring grain to Germany, in which case Bergen, Drontheim, and Narvick would be the ports, in case England permitted the Norwegian merchants to reap this rich harvest of trade and the grain was sent to Trelleborg and from there on German boats to Stettin or Lübeck.

"But for this purpose the hundred grain trains of thirty cars each must travel daily 1,400 to 2,000 kilometers over mountains that rise into the 'eternal snows.' Is this technically practicable? The roads of Sweden and Norway are one-tracked, and even if it were technically possible, it is a dead sure thing that England would quickly put an end to this traffic. . . . The case does not look very rosy for Germany. But it is a major concern of the state not to allow half the population to starve, as they did in the Thirty Years' war. The maintenance of the population, at the least *in statu quo*, is the most distinguished achievement of the statesmen, aside from ethical reasons. . . ."

After completing these highly pessimistic observations, Dr. Ballod asks what could be done, and proceeds to follow his destructive criticism by constructive suggestions. Remarking coolly that the civil population could not expect to receive its full normal rations, he continues:

"In the first year of war the consumption of meat and milk would be cut down to 75-80 per cent of the normal, even in case all the young cattle and three fourths of the swine were slaughtered to save feed. All the more care would have to be taken not to cut the bread allowance, so that the highly nutritious ani-

mal food might be, at least in part, replaced by vegetable food (bread). Rye and wheat might be more exhaustively milled, reducing the customary 25-30 per cent of bran to 5 per cent. . . . But we must not forget that the albumen of bran can be utilized only by the animal stomach and not by the human; thus a part of this important animal foodstuff would be diverted and serve merely to fill men's stomachs without nourishing them."

The real safeguard, he contends, is the laying up of stores of bread grain in times of peace so as to be ready for war. Thus does a brilliant, modern economist take a lesson from Joseph, the Israelite, who in the fat years of Egypt stored grain for the lean years! Dr. Ballod thinks it advisable that even in times of peace it is well to keep stored at least 2,500,000 tons of grain. He would have great granaries built in the large cities and regions of supply. Another reason for this is that after the outbreak of war train service is absorbed by mobilization. These granaries should each hold about a year's supply for the region served. Such regions of supply are the territory of the Rhine, of Rhinish Westphalia, Hessen-Nassau, and South Germany. "The latter brought in by water a surplus in 1909-1911 alone of 1⅝ million tons, of which 1½ million tons were wheat and ½ million tons rye. . . . Under present conditions an outbreak of war would, within a few weeks, spell catastrophe for the industrial population of West Germany. In a short time the price of bread would rise to a figure prohibitive to the mass of the population."

In such a pass he considers the only remedy would be for the state to confiscate all grain, as in the siege of a fortress, and deal out rations proportioned to the amount of provisions on hand, adding with sinister emphasis, that a great infant mortality could not be avoided, and that doubtless the dreaded "hunger-typhus" would claim many victims.

"The better way, true statesmanship, would be to make preparation beforehand . . . like Frederick the Great, who by a shrewdly planned system of magazines not only kept his army in fighting trim, but kept the civil population at least *in statu quo*, despite the suffering in Silesia, during the Seven Years' war, while in the neighboring territories of Austria starvation claimed dreadful sacrifices."

The next point considered is the number of men who would be called out and the industrial disturbances and changes consequent on this as well as in the cessation of import and export traffic, the closing of factories, etc. He takes a very lugubrious view of the result as liable to turn back the hands of Germany's marvelous progress some two hundred years and putting her at a lower point commercially than such small countries as Finland, Switzerland, or Belgium. He says:

"It is obvious that in a great war, waged for the very existence of kingdoms and nations, every available man must be called out." Here follow statistics as to the men subject to military service. Excluding aliens, there are about 9,000,000 males between the ages of 20 and 39, and of these he estimates that there were, at the end of 1913, 4,900,000 who had the proper military training. Of these, he says 3,300,000 would doubtless be sent to the front, and 1,600,000 at most retained as reserves.

"All trades would be seriously affected; agriculture least, but even so, agriculture would have to count on losing 1,000,000 active wage-earners, and it is a question whether those left could maintain intensive culture at the point to which it has at present attained."

However, he suggests that the proportions of the crops could be altered to suit the most crying needs, provided, of course, that the war broke out early enough in the spring to make the change in acreage and that enough seed-grain were on hand.

The "heavy" industries such as mining, foundry work, and machine making, would lose 30 to 35 per cent of their strongest men, but the textile industries would not be severely drained. Building would cease, so there would be less demand for iron and coal, but the textile industries would be forced to stop work in a few weeks because of the lack of raw material.

"Silk and cotton factories depend entirely on foreign imports and there are practically no stores on hand. The wool and flax industries to-day import nine tenths of their raw material from foreign countries. Things were very different in 1870. . . . However badly the military authorities needed clothes for troops, they could not be provided when the uniforms now on hand are exhausted. Hence, provision should be made for storing rawstuffs at least sufficient to supply the reserves with uniforms, and for sweaters in case the war last into fall and winter. . . . The civil population can wear old clothes if need be; the soldiers must have plenty of clothes, and warm ones."

Another suggestion he makes is that by a system of organized credits electrical firms and those making agricultural implements might be enabled to furnish great quantities of reaping machines, electric plows, and potato harvesters. Thus many of the unemployed would find work, the vital interests of agriculture would be served, and the oxen now employed for farm work could be sent to the butcher, which would furnish extra meat and also save fodder for the milk-cows. But he fails to show how a destitute population is to obtain and operate these expensive implements.

After declaring that Germany has much to learn in the way of efficient economic preparation, he utters this pregnant warning:

"Not only adequate or inadequate military preparation, but adequate or inadequate economic preparation will chiefly decide victory or defeat, or even the existence or non-existence of states and dynasties."

Vital Processes and Physics*

THE general distinction between the "descriptive" and the "exact" natural sciences is that the former are concerned with phenomena, the latter with the causes of natural processes. The two fields overlap in many parts, but not so extensively as is desirable and even possible in the present state of science. The most important work in overlapping regions has been accomplished in dynamic geology, and, following the initiative of Julius von Sachs, in vegetable physiology.

In the science of the vital properties of animals and men, investigators endowed with the erudition and ability of Helmholtz and A. Fick have always been rare, and in pathology, the science of the behavior of morbid organisms, very little has been accomplished in the certain and quantitative assignment, by scientific methods, of causes to observed events. The chemical processes of life were the first to receive serious, though inadequate, study; the phenomena most neglected are those of motion, which are so abundant in the records of the descriptive sciences.

For every action a cause must logically be assumed, and the cause of any motion or change of motion is called force. Here lies the field in which the co-operation of descriptive and exact science is now most urgently needed, and it is incumbent on the representatives of each branch to study and learn the other more thoroughly than they have done hitherto.

The phenomena of motion in living organisms that have been accurately observed and described are manifold and almost innumerable. It would be a very good thing to take up at last the important task of discovering the cause of these motions, which can be nothing else than a force. In this work, as in physics, the science especially concerned with motion, the most valuable aid will be furnished by mathematical analysis. The physicist deals with problems which either are comparatively simple in themselves, or can be so simplified by an ingenious plan of experiment that they can be treated mathematically. The field of the physicist is strictly confined to inanimate nature.

Animate nature exhibits many phenomena of motion that are far too complex for mathematical treatment at the present time; but it also presents more simple phenomena, which are quite amenable to such treatment. In any case it is possible to find among known forces of nature one to whose action the observed phenomenon may be chiefly assigned. Whether it is a force that acts only at intermolecular distances, such as osmosis, inhibition, surface tension, thermal expansion, etc., or a force that acts at greater distances, such as gravitation, electricity, or magnetism; this, at least, can certainly be determined. In my opinion, researches of this character should soon form an important part of biological work. They will require some preliminary education in physical science, which will perhaps make such vague expressions as "electric charge" and "magnetic attraction" less common than they are now.

When Woehler, in 1828, synthetically produced urea, a chemical compound then known only as a product of the animal organism, a powerful impetus was given to the development of organic chemistry. Already the carbon compounds that can be made artificially are far more numerous than those known to exist in nature, and no one can doubt that the same chemical laws govern the organic and inorganic worlds. This conviction has given the death blow to the old doctrine of "vital force," and it has been assumed that the organic and inorganic worlds are also moved by the same physical forces. This impulsion, one might almost say compulsion, toward unity has greatly promoted the development of the natural sciences. Every research, if it is to be truly scientific, must aim at the demonstration of this unity, especially of effective forces, in each individual case.

If this cannot be accomplished, it is certainly better to doubt one's own ability or the adequacy of the methods employed than to doubt the unity of natural forces. But even here there is a limit, and genuine science must not be afraid to break with the most firmly founded assumptions if they are found at variance with certainly demonstrated facts.

If the biologist, not content with describing movements and designating them as expressions of life, seeks their causes and finds that known physical forces are insufficient to produce them, then, and then only, the action of a "new force" may, or rather must, be assumed. This has always been done in physics; for example, when electrical phenomena were first observed. It must be proved, however, that the new force is competent to produce the observed movement and, even then, the new force must be cast aside as soon as anyone proves that it is superfluous and that the movement can be produced by a combination of known forces.

Both conditions, positive and negative, are satisfied in the case of an inconspicuous movement, observable only under the microscope, that accompanies the fertilization of the egg of the star-fish.[1] All known physical forces can be excluded with certainty, and the observed phenomena accord, with astonishing exactness, with the theory of a new force which, like gravitation, is universally proportional to the square of the distance. Although new force is dependent upon the life of the masses from which it emanates and upon which it acts, it is not a mysterious "vital force," but a force as real as gravitation. It is not likely that the action of the new force is restricted to the single case that has been observed. Probably many other instances exist in the organic world, but they can be discovered only by biologists who possess the requisite knowledge of the exact sciences.

The mind revolts at the idea of a real physical force that acts only on living matter and is extinguished with life, but the contrast between this and other physical forces is no greater than the contrast between life and death, in general.

*Translated from Richard Geigel's article in *Die Umschau*.

[1] Arch. f. mikroskop. Anatomie, Bd. 80, Abt. II, S. 171, u. Bd. 84, Abt. I, S. 453.

Wreck Statistics for 1913

THE statistical summary of vessels totally lost, broken up, condemned, etc., now published by Lloyd's *Register*, shows that during 1913 the gross reduction in the effective mercantile marine of the world amounted to 665 vessels of 717,030 tons, excluding all vessels of less than 100 tons. Of this total, 371 vessels of 533,002 tons were steamers, and 294 of 184,028 tons were sailing vessels. These figures, as regards steamers, are lower than those for 1912 by 39,543 tons; but as regards sailing vessels, they are for the year 1913 somewhat higher, viz., by 7,808 tons. One of the most common terminations of a vessel's career is breaking up, dismantling, etc. (not in consequence of casualty). The amount of tonnage so dealt with in 1913 was 108,795 tons, this being 48,846 tons less than that for 1912. Nearly 20½ per cent of the steamers and 16 per cent of the sailing vessels removed from the merchant fleets of the world in the course of 1913 are accounted for in this manner. Of the total tonnage of such cases 42¾ per cent is represented by United Kingdom vessels. The statistical tables exhibit interesting data as to the relative frequency of the different kinds of casualty, etc., which conclude the existence of vessels. Stranding and kindred casualties which are comprised under the term "wrecked," are much the most prolific cause of disaster. To such casualties are attributable over 58½ per cent of the losses of steamers, and over 54 per cent of sailing vessels. Cases of abandoned, foundered, and missing vessels are no doubt frequently more or less similar in the circumstances of loss. If these be taken collectively, they form about 21¾ per cent of the steamers, and over 29 per cent of the sailing vessels removed from the mercantile marine during 1913, owing to casualty.—*Marine Engineer and Naval Architect.*

The Future of Engineering Progress

IF progress continues along the lines now followed by pure and applied science, it is predicted by Prof. A. Ranum that it will surely lead to practical applications and new inventions that will startle the world. The material and utilitarian progress of to-morrow will depend largely on the scientific progress of to-day. Moreover, increased accuracy and efficiency in engineering can be met only by broadening and strengthening its mathematical foundations. Many an engineering student of to-day will live to see the time when those engineers who are leaders in their profession, who are capable of meeting novel conditions where originality of thought and action is required, will be men who are thoroughly trained in the use of many of the higher branches of what we now call pure mathematics.

NEW BOOKS, ETC.

PATTERN-MAKING. By Frederick W. Turner and Daniel G. Town. New York: John Wiley & Sons, Inc., 1914. 12mo.; 144 pp.; illustrated.

Written for use in vocational and industrial schools, this text outlines the materials, tools, and processes of pattern-making. It is a primer of the trade, designed to open the way to such books as can appeal only to one who has mastered the elementary practice.

CROP PRODUCTION. An Agricultural Text for Schools. By Clarence M. Weed and William E. Riley. New York: D. C. Heath & Co., 1914. 12mo.; 246 pp.; illustrated. Price, 75 cents net.

In a beautifully illustrated text the authors set forth the nature and requirements of vegetable, flower, fruit, and farm crops. The work employs what is known as the "project method," replacing symbols by realities and furnishing the teacher with many simple outlines preliminary to the text.

SECOND COURSE IN ALGEBRA. By William Benjamin Fite, Professor of Mathematics in Columbia University. New York: D. C. Heath & Co., 1914.

Students who have already taken the year's course for beginners will find in this text-book a review of first-year subjects and a logical development of the study that will take them through their second year and fit them for passing college entrance examinations in the subject. Abstruse and complicated problems are avoided; those referable to physics and geometry are given preference. Ratio and proportion is dealt with under fractions. In treating of the loci of equations of the second degree in two variables, the simpler cases only have been noted.

PRESERVATIVES AND OTHER CHEMICALS IN FOODS. By Prof. Otto Folin, Hamilton Kuhn Professor of Biological Chemistry in Harvard University, Cambridge: Harvard University Press, 1914.

Prof. Folin's little book on "Preservatives and Other Chemicals in Food" is one of a series of Health Talks, setting forth in a popular way the substance of some of the public lectures delivered at the Medical School of Harvard University. It contains much valuable information on the methods of preserving perishable foodstuffs, beginning with the old family practice of the application of heat or cold, down to the extensive use of chemicals in our modern canning and cold storage industries.

The fundamental problem of preserving foods, and one which for twenty years has confronted the scientists engaged in finding a proper solution of this problem, meant the making of that food unfit for bacteria to live in, but still fit for human consumption: this necessitated much experimenting with various chemicals and delving into the science of bacteriology. The new methods thus evolved after long years of hard work and exhaustive research, were unfortunately not left in the hands of these disinterested investigators, but they became money-making schemes seized upon by men whose main interest was a pecuniary one.

Prof. Folin comments at some length on Dr. Wiley's long and untiring fight against the indiscriminate and unscrupulous use of chemicals in foodstuffs. Rather unique is his idea of the best method of observing the effect of these "preservatives" on humans. He advocates the trying out of various substances used in preserving foods on the inmates of prisons, not because they are prisoners whose fate or health is of little consequence, but because they are the largest body of persons available whose habits are essentially regular and uniform, and whose health record could easily be kept for a long period of years.

THE POLYTECHNIC ENGINEER. Published Annually by the Students of the Polytechnic Institute of Brooklyn. Vol. XIV., 1914. 8vo.; 164 pp.; illustrated. Subscription price, $1.25 per copy.

This is an annual having for its chief aim the encouragement of undergraduates in the writing of scientific articles. About half the papers in this issue were written by the faculty; the other half are the work of undergraduates and the alumni. These papers are informative upon such subjects as underground construction, industrial illumination, street planning, the valuation of railway property, and the determination of stress. They exhibit varying degrees of interest and usefulness, and altogether make up a creditable collection.

SCIENCE AND RELIGION. The Rational and the Super-rational. An Address Delivered May 4th, 1914, before the Phi Beta Kappa Alumni in New York. By Cassius J. Keyser, Ph. D., LL. D., Adrian Professor of Mathematics in Columbia University. New Haven: Yale University Press, 1914. 12mo.; 80 pp. Price, 75 cents, net.

The author has perhaps wisely omitted to give us his own definition of religion, although it is difficult to follow and appraise arguments for or against a state of consciousness represented by a word meaning different things to different men, unless the word is defined rather strictly for purposes of discussion. Broadly, the writer supports a belief in the super-rational, strictly limiting the rational and placing the vitalizing element of religion above reason's plane. The address is an admirable piece of work, a striking example of the academic style at its best. While we may not always be able quite to make our footprints coincide with those of Prof. Keyser, we set our face toward the same goal. He has given us a well-proportioned construction of modern thought, invigorating in its procedure and sound in its deductions.

THE HYDROGENATION OF OILS. Catalyzers and Catalysis. The Generation of Hydrogen. By Carleton Ellis, S. B. New York: D. Van Nostrand Company, 1914. 8vo.; 425 pp.; 145 illustrations. Price, $4 net.

The oil industry has such important outgrowths and ramifications that a work amalgamating the scattered literature of hydrogenation and allied processes should be welcomed by all who are in any way interested in these subjects. The author very fully explains the methods of hydrogenation, and their application in the fields of food manufacture, soap making, etc. The work concludes with a chapter on safety devices and some citations from patent litigation. Both student and worker may benefit by the wide range of information, the processes and the suggestions contained within this volume.

THE QUESTION OF ALCOHOL. By Edward Huntington Williams, M. D. New York: The Goodhue Company, 1914. 12mo.; 121 pp. Price, cloth, 75 cents; flexible leather, $1.25.

These papers embody a protest against the exaggerated teachings of the school text-books for it is the opinion of the writer that these exaggerations defeat their own purpose. Indeed, this position is defended by statistical deductions. Liquor legislation is also censured, and is held responsible for the alarming increase in whisky drinking and drug taking. The little volume is not, however, merely destructive and reactionary. It makes sensible suggestions toward remedying existing conditions, but by methods evolutionary rather than revolutionary.

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY. Vol. XVI. Arthur S. Watts Editor. Published by the Society. Secretary's Office, Columbus, Ohio, 1914.

This annual carries, as usual, a fund of instructive material relating to clays and pottery. It chronicles also the proceedings of the meeting held at Wheeling, W. Va., February 24th, 25th, 26th and 27th of this year. To the papers read at the meeting are added supplemental essays on practical themes. There are comparisons between English and American glaze practice, hints on experimental enamel making, notes on the preparation of feldspar, and some fifty other discussions of varying interest and usefulness.

STEEL WORKING AND TOOL DRESSING. A Manual of Practical Information for Blacksmiths and All Other Workers in Steel and Iron. By Warren S. Casterlin. New York: M. T. Richardson Company. 1914. 8vo.; 207 pp.; illustrated. Price, $2.

This is a plain talk to his brother blacksmiths by the dean of the order. For it has taken fifty-seven years at the anvil for Mr. Casterlin to acquire the knowledge that he now disseminates. He has made a special study of cast steel, and sketches the process of its manufacture with enthusiasm and thoroughness. The young iron worker will find here helpful instructions simply conveyed.

EXPERIMENTS. A Volume for All Who Are Interested in Progress. By Philip E. Edelman. Minneapolis, Minn.: Published by the Author, 1914. 8vo.; 256 pp.; illustrated. Price, cloth, $1.50; leather, $3.

A very attractive series of experiments, selected with a view to making the student acquainted with modern progress and the ways in which it has found itself, are presented here by the author. The first division of his work is devoted to simple grouped and graded experiments that include some of the most fascinating demonstrations in chemistry, electricity and mechanics. The second division takes up the principles of original research in science, invention and the industries. Plates, engravings and half tones in profusion brighten the work and are indeed indispensable to a ready understanding.

SECOND COURSE IN ALGEBRA. By William Benjamin Fite. New York: D. C. Heath & Co., 1914. 12mo.; 247 pp. Introduction price, 90 cents.

This book is planned to follow the author's First Course in Algebra which has received so much favor because of its scholarly and teachable qualities. It provides ample preparation for entrance to college and technical schools. It is written in the same spirit as the author's First Course but advantage has been taken of the fact that those who study it will be somewhat older and more mature than beginners of the subject. Complicated and artificial problems have been avoided. There is an abundance of material for drill and practice and for illustrating the applications of algebra to physics and geometry. The subject of ratio and proportion is treated in a chapter on fractions where it naturally belongs. The use of graphical methods which was begun in the First Course has been extended. The whole treatment is concrete and direct and represents the high water mark of mathematical text-book making.

A STUDY OF FOODS. By Ruth A. Wardall, M. A., and Edna Noble White, A. B. New York: Ginn & Co., 1914. 12mo.; 174 pp.; illustrated. Price, 70 cents net.

This text is designed neither for the finished cook nor the food expert. It is rather adapted to eighth grade or high school classes, while the laboratory exercises may readily be worked out in the home. The nature of raw materials and the effect upon them of heat and manipulation is set forth in a fundamental way. In view of present high prices, cost consideration is given the importance it deserves. The student is well drilled in the calculation of costs, both of raw material and of the perfected dishes. The various cuts of meat are fully illustrated and their uses and values clearly defined.

HIGH-POWER GAS ENGINES. By H. Dubbel. Translated from the German and Edited and Expanded so as to include British Engines and British Practice by F. Weinreb. New York: D. Van Nostrand Company, 1914. 4to.; 197 pp.; 423 illustrations and 13 folding plates. Price, $5 net.

The large gas engine, combining as it does the constructional features of the steam engine with the working cycle of the small internal combustion engine, is entitled to a separate literature and special consideration. Perhaps the most distinctive claim of the work in hand is based upon its many sectional drawings on a large scale. English firms have consistently refused to furnish the finer details of their practice, and to this reticence may be partly due, as the translator suggests, their failure to profit by the interchange of ideas as the Continental manufacturers have done. Since Mr. Dubble's work deals only with the larger, double-acting type, while in England the tendency is toward multi-cylinder, single-acting systems—due, no doubt, to difficulties experienced with large cylinders—the translator has added to the original work much relating to modern British practice. His reference to some abandoned designs, with the reasons for their abandonment, should save considerable labor in wrong directions. Altogether the volume may be highly commended to inventors and manufacturers.

MOTORCYCLES, SIDECARS AND CYCLECARS. Their Construction, Management and Repair. By Victor W. Pagé, M.E. New York: Munn & Co., Inc. 550 pp.; 350 illustrations. Price, $1.50.

Those who have read Mr. Pagé's book on the automobile will welcome this volume on the motorcycle, in which he treats his subject with his usual thoroughness and clearness. Previously to this there has been nothing of a competent nature published in this country on the motorcycle, but in Mr. Pagé's book every detail of motorcycle construction is carefully explained, including power plants of both two and four cycle design, and various systems of carburetion, ignition and lubrication. Clutches, speed change gears, starting devices and brakes are fully covered and illustrated by numerous cuts of the best American and foreign machines; while for those who require technical information many useful tables and formulæ are given. Sidecars are fully covered, and a chapter is devoted to the cyclecar that is instructive. While the matter covered is mainly descriptive and explanatory, some space has been devoted to the practical questions of operation and maintenance. As a whole, it is a useful book of reference, and by far the best of its kind yet published.

THE PHILOSOPHY OF RADIO-ACTIVITY. Or Selective Involution. By Eugene Coleman Savidge. New York: William R. Jenkins Company, 1914. 8vo.; 151 pp.; illustrated. Price, $1.50 net.

In radio-activity we have an energy 250,000 times greater than any hitherto known. The author has made this energy the text for some able speculations upon the nature and properties of matter. His thought is always pregnant, and his expression vigorous even when it is most vague. With all due respect to the difficulties of the subject, there are many places in which the thought might have been more lucidly expounded. Still, a deep and stimulating work remains. Wherever the more familiar physiological processes are entered upon the touch is sure, the reasoning sound. The close analogy between radium emanation and recovery and the glandular process should throw light upon the latter and lead to important discoveries. We look forward with some eagerness to Dr. Savidge's forthcoming volumes on "The Cancer Problem" and "The Unclassified Diseases," to which the work in hand is a kind of preface.

POLITICAL ECONOMY. By Charles Gide, Professor of Social Economics in the Faculty of Law in the University of Paris. Authorized Translation from the Third Edition (1913) of the *Cours d'Economie Politique*. New York: D. C. Heath & Co. 8vo.; 762 pp. Price, $3 net.

"Political Economy" is a term of rather forbidding aspect, but its dry reputation need deter no one from following with pleasure the intensely interesting exposition given us by Prof. Gide. From his early recognition of the invasion of natural law into the social world, to his closing sections on saving and expenditure, there is scarcely a dreary line in the work. Production, its factors and organization, receives premier consideration. Circulation and the monetary systems follow. The third book is devoted to distribution, and the fourth to consumption. All branches of the science are thus ably covered. The various schools of socialism, liberalism, and "solidarity" are clearly defined, and this feature alone, in consideration of the haze enveloping the average mind as to the tenets and aims of these antagonistic parties, makes the book worthy of popular persual. It was written with the object of aiding French students in their Law Faculty examinations, and hence takes a distinctly French point of view, but the notes of this American edition cater especially to the student of our own land, and to both student and general reader the text may be heartily commended.

THE LUMBER INDUSTRY. Part IV. Conditions in Production and Wholesale Distribution including Wholesale Prices. Washington: Department of Commerce, Bureau of Corporations, 1914.

This report largely deals with the investigation authorized by the Senate and the House, and with the price-fixing combinations among manufacturers and wholesalers. The lumber associations and their activities are thoroughly canvassed, and the opinion arrived at seems to be that, while some purposes have been beneficial in aim both to producer and consumer, wholesale prices have been advanced by doubtful expedients and legislation has been shaped—or attempts been made to shape it—by aggressive lobbying and similar methods of persuasion or coercion. The report is a mine of information concerning production and distribution, with many charts covering from 10 to 17 years and indicating the movement of prices, the comparison of actual and list prices, and the fluctuations of different grades.

TEXAS NATURE OBSERVATIONS AND REMINISCENCES. By R. Menger, M.D. San Antonio, Tex.: Guessaz & Ferlet Company, 1913. 8vo.; 323 pp. Price, $2.

The present volume details private observations on Texas insect and animal life in general. Many of the illustrations are of great interest to naturalists.

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